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Toxicological studies on the molt-inhibiting insecticide (EL-494) against the gypsy moth (*Lymantria dispar* L.) and effect on chitin biosynthesis. A. H. Abdel-Monem, E. A. Cameron and R. O. Mumma, Pest. Res. Lab. and Grad. Study Ctr. and Dept. Entomol., The Pennsylvania State Univ., University Park, PA 16802

All larval instars of the gypsy moth (*Lymantria dispar* L.) were fed on an artificial diet containing 13 different concentrations varying from 0.0 to 2.0 ppm of EL-494 (N-[[[5-(4-bromophenyl)-6-methyl-2– pyrazinyl]amino]-carbonyl]-2,6-dichlorobenzamide), a molt-inhibiting insecticide, and the larvae were scored for their ability to molt subsequently to healthy individuals. Gypsy moths were scored for molting abnormalities as follows: 1) failure to feed, 2) partial ecdysis ranging from retention of old head capsule to failure to completely remove the old cuticle from the abdomen, and 3) death prior to molt. The 5th and 6th larval instars were the most susceptible while the 1st and 2nd larval instars were the least susceptible. Adult emergence, especially of females, was reduced by concentrations of EL-494 that did not show any effect on the larval stages. To investigate the effect of EL-494 on chitin biosynthesis, 5th instar larvae were fed on artificial diet containing either 0 or 20 ppm EL-494 for 24 h and then were injected with 0.1 μCi ^{14}C-glucose. After 24 h the larvae were sacrificed and the amount of ^{14}C incorporated into various fractions was determined. Larvae fed on diet containing EL-494 reduced (ca. 80%) the incorporation of ^{14}C-glucose into chitin relative to the control and clearly indicated the inhibition of chitin biosynthesis by EL-494.

Toxicological response of Japanese beetle (Copeoptera: Scarabaeidae) grubs to insecticides. S. Ahmad, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Dosage-mortality response and toxicological symptoms following topical treatment of 3rd stage grubs of a Japanese beetle *Popillia japonica* Newman population from Rivervale, N.J., were studied. The 8-day LD_{50} and LD_{95} for chlorpyrifos were 1.88 and 55.24 μg/grub, respectively. For the slower-acting insecticide dieldrin, the 14-day LD_{50} and LD_{95} were 26× and 32× more than chlorpyrifos, respectively. Dieldrin resistance in these grubs is thus indicated and is in agreement with similar findings from Connecticut, New York, and Ohio. The high ratio of LD_{95} and LD_{50} (29:1) with chlorpyrifos may also be indicative of incipient organophosphate resistance in

New Jersey grubs. Grubs treated with either insecticides moved up to the soil surface, remaining there for one or more days, progressed to the advanced stage of poisoning and died. When recovering from insecticide action, the surfaced grubs dug back into the soil. The surfacing behavior may be related to general hyperactivity often discerned as an initial effect of insecticides on insects. Grubs in advanced stage of poisoning were characterized by 3 distinct symptoms: 1. shrinkage in size and reduction in body weight to ca 50%, 2. Yellow-brown coloration of the body instead of the normal whitish appearance, and 3. moribundity.

Correlation of common plant taxa phenologies to development of *Agromyza frontella* (Rondani) (Diptera: Agromyzidae). J. T. Andaloro, T. M. Peters and A. J. Alicandro, Univ. Massachusetts, Amherst, MA 01003

Throughout the spring and summer of 1978 the phenological stages of various plant species were recorded to determine their utility as indicators of events occurring in the life history of the Alfalfa Blotch Leafminer (ABL) *A. frontella*. A major objective was to determine the reliability of forecasting ABL seasonal development through the use of specific plant phenologies. These data are expected to increase the efficiency of ABL sampling, pest outbreak detection, and possible control programs. In studies at Amherst, MA first emergence of *A. frontella* adults from overwintering pupae was detected on May 11 (Julian calendar day 131) paralleling the beginning of bloom (BOB) stage of Pin Cherry *Prunus pennsylvanica*, and *Magnolia soulangeana* petal fall. Four days later Common Horse Chestnut *Aesculus hippocastanum* (BOB) coincided with initiation of ABL oviposition. Detection of the first mine was not until May 25th in concurrence with Bridal wreath *Spiraea prunifolia* at full bloom (FB), High Bush Blueberry *Vaccinium corymbosum* (FB) and Choke Cherry *Prunus virginiana* (BOB). Alfalfa *Medicago sativa*, flowering (BOB) on June 6 correlated with similar phenological stages of Black Locust *Robinia pseudoacacia* (FB) and Blackberry *Rubus allegheniensis* (FB).

Alfalfa at (BOB) supported an average of 54 mines/stem. Abandoned mines represented 25% of the total number, third instars 30%, first and second instars 37%, and dead larvae due mainly to parasitization 8%. Forty-two days and 875 Degree days elapsed from detection of the first generation egg until adult emergence.

Integrated control of cotton bollworms in P.D.R. of Yemen. S. A. Ba-Angood, Dept. of Entomol., Macdonald College, McGill Univ., Que., HOA 1C0

P.D.R. of Yemen has recently emerged as a moderate exporter of long stable cotton. During a 7-year period 1971 to 1977 inclusive, extensive studies have been carried out on the control of cotton bollworms. As a result an integrated control program has been planned which resulted in a reduction in cotton bollworm infestation from 70% (in 1971–72) to about 15% (1976–77). The results of these studies which lead to this integrated control program show that (1) early sowing date (late July to late August) produced twice the yield of late sown cotton (late September and October) without insecticidal treatment (2) spraying at 18% bollworm infestation gave significant difference in yield in comparison with 10% and no-spray treatments. This resulted in reducing the number of sprays from 4 to 1. (3) Strict close season from the end of May till the 3rd week of July and early watering of all the land cropped with cotton the previous year reduced infestation with bollworms and specially the Sudan bollworm *Diparopsis watersi* and resulted in high yield. (4) Monocrotophos (nuvacron 40), chlorpyrifos (dursban 4), carbaryl + molasses (sevimole 4) proved to be very effective against bollworm complex. Carbaryl (Sevin 85) was less effective against the American bollworm *Heliothis armigera*. (5) Parasites and predators contributed to control only on early stages of infestation (September–October).

Bionomics of the New Zealand genera *Neolimnia* and *Eulimnia* (Diptera: Sciomyzidae). J. K. Barnes, Cornell Univ., Ithaca, NY 14853

The endemic New Zealand genera *Neolimnia* and *Eulimnia* are typical members of the cosmopolitan mollusc-eating subfamily Sciomyzinae and of the largely predatory tribe Tetanocerini, and their larvae have evolved diverse food preferences. In *Neolimnia* the four species of the subgenus *Pseudolimnia* have aquatic larvae and puparia that are similar to the majority of known Tetanocerini. As is typical of the aquatic predatory sciomyzids, larvae of most of these species feed upon aquatic pulmonate snails, but *Neolimnia tranquilla* (Hutton) seems to prefer the operculate snail *Potamopyrgus antipodarum* (Gray) (Prosobranchia: Hydrobiidae). Adults and immature stages of the subgenus *Neolimnia* are usually collected in moist forests near marshy areas. The larvae and puparia are not capable of life in open water. The larvae prey upon tiny terrestrial snails, especially those of the family Punctidae (Pulmonata), killing and consuming the snails quickly. Larvae of *Eulimnia philpotti* Tonnoir and Malloch are subsurface predators of fingernail clams (Bivalvia: Sphaeriidae). They are adapted for life in the muddy substrates of marshy areas. Long, narrow, tracheated lobes on the

posterior segments are exposed to passing water currents while the anterior end of the larva is buried in the substrate or in the tissues of fingernail clams. The larvae kill and consume the clams quickly, and they consume many clams before the late third instar larva leaves the water to form a puparium in surface vegetation or debris.

Simplified artificial diet and rearing techniques for the gypsy moth, *Lymantria dispar* L. (Lepidoptera: Lymantriidae). R. A. Bell, M. Shapiro and C. Owens, USDA SEA/FR, Otis AFB, MA 02542

Large numbers of gypsy moths are required for *in vivo* production of pathogens and parasites and for conducting laboratory and field tests with alternative (autocidal) control measures such as the sterile male technique. Since the high cost of rearing has heretofore been a limiting factor in the development of biological and autocidal control methods, research was initiated to develop a simplified, inexpensive diet and a more efficient rearing system. Thus, a variety of alternative and less expensive diets, containerization and handling procedures were evaluated and modified. Subsequently a simplified wheat germ-casein or soy based formulation was developed that costs ca. 25¢/L and is nutritionally equivalent or superior to other more expensive diets. Of a variety of commercially available containers tested, best results were obtained with 6 oz. polyethylene (ME-6R or XE-6; Sweetheart Plastics) food cups fitted with paper lids. Insects were reared @ 8/cup containing 80/90 ml of diet from newly hatched larvae to pupation without a change of food. Adult recovery was 90% and the average time to pupation at 25°C was ca. 28 and 30 days for males and females respectively for a New Jersey F_{16} colonized strain. Wild strains reared by these methods showed similar survival and only a slightly longer developmental time. With these developments, the average cost of rearing the gypsy moth has been reduced from previously projected figures of $60–80 to a present estimate of $12/1000. With implementation of envisioned automation of infesting and pupal harvest, cost may be further reduced to $6–8/1000 insects.

Development of sequential sampling plans for insect defoliation on soybeans. R. G. Bellinger and G. P. Dively, Dept. Entomol., Univ. Maryland, College Pk., MD 20742

Sequential sampling plans based on the binomial distribution were developed for sampling insect defoliation on soybeans. The plans were simulated on actual data collected from over 300 fields where a fixed-sample size method (30 plants) was employed. Data were from two varieties of soybeans, York and Essex, from Maryland's Eastern Shore and represented a

range of field conditions and levels of infestation of Mexican bean beetle. *Epilachna varivestis* (Mulsant) (Coleoptera: Coccinellidae) over a three year period (1975–77). Plants were rated as economically damaged (>20% defoliated) or not economically damaged (<20% defoliated). Results showed that average savings in sampling time of 30% can be expected, with as much as 70% savings realized in fields with low (<10%) or high (>40%) defoliation. Plans chosen used $\alpha = .01$ or .05, $\beta = .01$, $\rho_1 = .2$ to .3, and $\rho_2 = .8$ to .7. Sequential sampling plans were in agreement with the fixed-sample method over 90% of the time. Within plant distribution of defoliation was characterized for the two varieties in 1976 and 1977. Differences in defoliation were found at various locations in the plant and were related to the population dynamics of the Mexican bean beetle and the morphogenesis of the plant. These findings are useful in the estimation of whole plant defoliation which is required by the sequential sampling plan. Sequential sampling plans used to sample insect defoliation on soybeans can result in considerable savings in scouting time and render on-the-spot control decisions with a predetermined degree of precision.

Performance of selected insecticides against pear psylla, *Psylla pyricola* Foerster (Homoptera: Psyllidae). W. M. Bode, Pennsylvania Sta. Univ. Fruit Res. Lab., Biglerville, PA 17307

Randomized and replicated single-tree plots of d'Anjou pear were sprayed with a handgun. Control was evaluated by counting psylla eggs and nymphs on 5 fruiting spurs per plot until petal-fall, and thereafter on 10 new leaves from growing shoots. Eggs and nymphs were counted in the laboratory with the aid of a binocular microscope. Adults were counted in the field by three minute examinations of individual trees and by tapping 3 branches per plot over a 18 in × 18 in cloth tray. Among prebloom treatments the combination of 2 gal of 70 sec. Superior oil plus 1 qt of either Perthane(R) 4 EC, phosalone 3EC, or amitraz 1.5EC per 100 gal of spray were most effective. The fungicide mancozeb suppressed populations of psylla eggs and nymphs appreciably. Petal-fall applications of amitraz (6 oz ai/100 gal), permethrin (0.1 lb ai/100 gal), and fenvalerate (0.05 lb ai/100 gal) were very effective. In summer cover sprays the performances of registered materials were variable, and some lost effectiveness with repeated applications. The pyrethroid products (permethrin and fenvalerate) were extremely effective at low rates (0.1 and 0.05 lb ai/100 gal). Insecticides labeled for pear psylla control may not be reliable unless rates are increased above those currently recommended in Pennsylvania. Mancozeb fungicides have significant activity against small nymphs and should be included in all sprays applied to pear.

Sampling procedures for collecting *Simulium penobscotensis* Snoddy and Bauer (Diptera: Simuliidae) and other Maine black flies. L. R. Boobar and J. Granett, Entomology Dept., Univ. of Maine, Orono, ME 04473

Two types of polyethylene samplers, ceramic fireplace tiles, Surber samples, 2 types of Hess samplers, vegetation collections and drift nets were used to sample black flies. Quantitative collections were made in the Pleasant and Penobscot Rivers in central Maine and black fly species and numbers compared. *Simulium penobscotensis* Snoddy and Bauer, a summer black fly species which bites humans, and *S. nyssa* Stone and Snoddy do not readily colonize tile samplers and were not collected by bottom samplers in numbers similar to collections on *Potamogeton* and *Sparganium* vegetation. Other black fly species colonized the artificial substrates about equally with bottom samplers being markedly inferior. *S. penobscotensis* and other black fly larvae were collected in drift nets in the Penobscot River. Samples on vegetation indicated that *S. penobscotensis* was found at least down to 1 m in the Penobscot River. The percentage of *S. penobscotensis* in the total black fly population increased with depth. The number of instars and frequency of each instar were estimated by head capsule width measurements. *S. penobscotensis* apparently has 7 instars, however, instar frequency was not uniform in collections. The bulk of the samples consisted of mature larvae and pupae. The lack of early instar larvae in collections indicated a different habitat for this age group.

Palatability studies on *Euphydryas phaeton* (Lepidoptera: Nymphalidae). M. D. Bowers, Univ. Massachusetts, Amherst, MA 01003

The ecology and behavior of both larva and adult *Euphydryas phaeton*, the Baltimore checkerspot, suggest that it is unpalatable. Thus, both larvae and adults exhibit conspicuous, non-evasive behaviors; the larvae are gregarious; and both larvae and adults are very brightly (warningly) colored. In a series of laboratory experiments using blue-jays as predators and the butterfly, *Cercyonis pegala* (Satyridae), as a palatable control, it was found that *E. phaeton* is indeed unpalatable, and in fact emetic, to the birds when fed throughout larval development on the primary foodplant, *Chelone glabra* (Scrophulariaceae), Turtlehead. Female oviposition and early larval development are confined to *C. glabra*, but in the later instars, larvae may become polyphagous, feeding on plants in 5 families. Butterflies which fed in early larval instars on *C. glabra* and in later instars on *Plantago lanceolata* (Plantaginaceae) were fed to blue-jays, again using *C. pegala* as a palatable control. These *E. phaeton* butterflies were palatable. In a single population of *E. phaeton*, therefore, one could find a range of palatabilities in the butterflies. The palatability of any individual would be dependent on the

amount of *C. glabra* eaten during larval development and could range from highly emetic (larvae fed throughout development on *C. glabra*) to quite palatable (larvae switched to alternate food soon after emerging from diapause in the spring).

Discriminant function analysis of the abdominal coloration variations in the large milkweed bug, *Oncopeltus fasciatus* (Dallas) (Hemiptera: Lygaeidae). M. W. Brown and C. W. Rutschky, Pennsylvania State Univ., Univ. Pk., PA 16802

The patterns of grey and black ventral abdominal coloration were measured on 25 males and 25 females from six laboratory cultures: Penn. State U., Virginia Polytechnic Institute, Fordham U., U. of Wisconsin, Connecticut A.E.S., and Cornell U. Linear discriminant function analysis of these data resulted in a 66.67% classification of each insect into the correct culture. Discriminant function analyses were also run on each sex separately to eliminate a sex-culture interaction, resulting in a correct classification of 64.00% for males and 70.67% for females. A plot showed that the separation of cultures was correlated with the geographical distance between institutions. The discriminant function distance from the Penn State culture to the Cornell culture was very small. The Connecticut culture lay close to both of these. The discriminant function analysis almost completely separated the V.P.I. culture from the previous three; the Wisconsin culture was located the farthest from the others. The insects from the Fordham culture showed the largest variance and overlapped all the other cultures; it was initiated with milkweed bugs from Connecticut and supplemented with insects from the Albany, NY area. The other cultures were started from insects collected within the vicinity of the institution.

Measuring honey bee foraging responses with an artificial flower. D. M. Caron and G. D. Waller, Dept. Entomol., Univ. Maryland, College Pk., MD 20742 and USDA Bee Res. Lab., Tucson, AZ 85719

Various sugar solutions were made available to foraging honey bees, *Apis mellifera* visiting artificial flowers. Capillary tubes extended downward through a blue plastic disk so the bees could remove sugar solutions from one of 6 vials. Amounts collected were used to measure relative acceptance by the bees. Up to six sugars or combinations of sugars were compared during each test.

Honey bees preferred sucrose over any other sugar or mixture of sugars. They preferred concentration varied between 30 and 60%. Addition of NaCl

strongly inhibited collection of sugar solutions at levels above 3000 ppm Na, but lower levels improved acceptance. Potassium contamination also inhibits collection. Sucrose solutions to which small amounts of maltose had been added were collected in preference to sucrose without the maltose. Addition of fructose, glucose, or trehalose had no such stimulating effect on honey bee foragers. The bee toxic sugars raffinose, xylose, galactose, lactose, and melezitose all had an inhibitory effect on collection of sucrose solutions by bees visiting the artificial flowers.

Different stock lines responded similarly to sugar and adulterated solutions. Selectivity is reduced if foraging populations are allowed to become too large. Tests are conducted in cages to limit populations and insure response measure from selected stock.

Observations on the life history of *Pseudeucoila* spp. (Hymenoptera: Cynipidae). P. C. Chabora and S. J. Smolin, Queens College, Flushing, NY 11367

A new endoparasite which attacks the larval stage of several *Drosophila* species was collected from several mid-east coast states. Adults of both sexes were found in shaded habitats on fruits in which *Drosophila* were breeding. This species is morphologically similar to *P. bochii* but differs in developmental and pheromone response characteristics. Studies of the coevolutionary patterns between interacting populations required a replicable procedure for quantifying the wasp's life history characteristics. Both parasite and host stocks originated from mass collections at Chapel Hill, N.C. in August 1976. Wasps will oviposit single eggs in host larvae 12–72-h-old, but to standardize procedures, hosts 24–48-h-old were used. Six *D. melanogaster* females oviposited on yeasted banana medium for 24 h to provide approximately 250 larvae. Each pair of wasps (23 replicates) were transferred to a fresh host vial daily until death. Emerging offspring were counted daily to provide a schedule of developmental rates and sex ratios. Male and female offspring began emerging at 16.5 and 17.5 days, respectively, until a total of 376.8 ± 58.9 offspring were produced at a 0.46 sex ratio. A net reproductive rate of 202.8 and the weighted generation time of 20.3 days yielded an estimated r of 0.26. This opportunistic species produced 53% of its total egg output in 24 h which accounted for 72% of its female offspring. Within 72 h, 75% of all eggs and 92% of female eggs were produced. Adult life expectancy was calculated at 15.8 days. (Supported by BHE-PSC Award 10189.)

Simulated defoliation and depodding effects on yield and quality of baby lima beans. D. L. Coggin and G. P. Dively, Univ. of Maryland, College Pk., MD 20742

Lima bean plants were defoliated and depodded to simulate the injury caused by phytophagous insects. Plants were defoliated at five levels (0, 1/6, 1/3, 2/3, 3/3) during five maturity stages (early prebloom, prebloom, bloom-pin, flat pod, mature pod). In another experiment pods were removed at four levels (0, 1/3, 2/3, 3/3) during three maturity stages (pin pod, flat pod, mature pod). Multiple regression methods were employed to develop separate equations for predicting yield reductions as a result of defoliation and pod loss for any maturity stage of the plant. Defoliation of 15% caused economic yield reductions at prebloom while 10% defoliation caused economic damage from bloom to harvest. Pod removal of 10% resulted in yield losses from the beginning of flat pod production to the beginning of mature pod production. Once mature pod production began, depodding reduced yields at increasingly higher percentages of pod loss. Leaf area and pod production of the lima bean plant were measured at various growth stages from field samples taken during 1976 and 1977 to obtain morphological data on the development of the plant. Based on average leaf area and pod production for each maturity stage and average leaf area and pods consumed in their development, static economic injury levels were calculated for the Mexican bean beetle and corn earworm, respectively.

Electrophysiological identification of oviposition-deterring pheromone receptors in *Rhagoletis pomonella* (Diptera: Tephritidae). R. M. Crnjar, R. J. Prokopy, and V. G. Dethier, Univ. Massachusetts, Amhert, MA 01003

Through structural ablation, it was previously demonstrated that receptors of oviposition-deterring fruit marking pheromone in *Rhagoletis pomonella* (Walsh) females are located on the fore tarsi. Ablation tests and behavioral observations suggested that additional but less important or less often utilized receptors may also be present on the mid- or hind tarsi and the mouthparts. Here, we used the hair-tip recording technique to electrophysiologically identify marking pheromone-sensitive sensilla and possible receptor response types.

The D-hairs on the ventral surface of the 2nd, 3rd, and 4th tarsomeres of the fore tarsi and the short (marginal) hairs of the labellum proved highly sensitive to a crude extract of the pheromone. Some pheromone sensitivity occurred also in the A and D hairs of the 5th tarsomere of the fore tarsi, D-hairs of the mid tarsi, and the largest hairs of the labellum. The D-hairs of 3-day-old (immature) females were just as responsive as those of 3-week-old (mature) females. The particular D-hair cell sensitive to the pheromone

does not appear to be the salt cell, though it may be the sugar cell. The pheromonal response pattern of the labellar short hairs implicates more than one cell type, though one cell is predominantly active. Stadler, Boller, and Katsoyannos (pers. comm.) have found tarsal D-hairs of *R. cerasi* females to be sensitive to the marking pheromone of that species.

Synergistic microbial attack on *Lymantria dispar* L. (Lepidoptera: Lymantriidae). R. A. Daoust and H. B. Gunner, Univ. Massachusetts, Amherst, MA 01003

In vitro and *in vivo* studies have demonstrated that chitinases of bacterial origin degrade the peritrophic membrane of the gypsy moth, *Lymantria dispar,* thus increasing larval susceptibility to infection. However, since most bacterial chitinases have a pH optima for activity between 5.0–6.0, the high alkalinity in the mesenteron of *L. dispar* larvae severely limits chitinolysis of the midgut lining. Fermentative acid-producing bacteria isolated from healthy gypsy moth larvae, although nonpathogenic, effectively lowered larval mesenteron pH when administered per os. The combination of fermentative isolates with a crude culture and supernatants from a centrifuged culture of a strong chitinolytic isolate produced synergistic increases in mortality over either dose administered by itself. The principal role of these fermenters was to poise midgut pH and thus to enhance the action of chitinases in the degradation of the peritrophic membrane. This was confirmed through the microscopic examination of cadavers and by classifying dead larvae according to their symptoms and mode of death. Although *in vitro* studies showed that other bacteria isolated from environments foreign to that of the gypsy moth could ferment carbohydrates with acid production at an alkaline pH, *in vivo* studies demonstrated that these bacteria were incapable both of poising larval midgut pH and of enhancing mortality when added to chitinolytic bacteria. Microorganisms isolated as resident flora from healthy larvae were, therefore, ecologically better adapted to the pest.

The nature and distribution of European corn borer (Lepidoptera: Pyralidae) feeding injury on snap beans. G. P. Dively II and J. E. McCully, Univ. of Maryland, College Pk., MD 20742, and Regional Agricultural Agronomist, Green Giant Co., Le Sueur, MN

Egg masses were placed on snap beans at 7, 14, 21 days before harvest to determine the nature and distribution of feeding injury by *Ostrinia nubilalis* (Hübner). Early instars fed first on leaves and then bored into stems and pods as they reach the late 2nd and 3rd instars. About 37% of the stem damage occurred inside the lower portion of the main stem, with the re-

maining damage distributed among lateral stems. Second and later instars invaded all sizes of pods with a significant preference toward the marketable pods (sieve sizes 3–6). External symptoms indicating that the pods had been damaged were not consistently observed. Many marketable pods were completely normal in appearance despite extensive boring, and the only sign of injury was the entry hold. Injury to pin pods (sieve sizes 0–2) invariably was associated with external symptoms, and it is likely that these pods develop to a marketable size. The nature and distribution of feeding injury to pods and stems depended on the time of oviposition. When hatching occurred at bloom, about half of the surviving larvae invaded pods of all sizes and caused little external evidence of injury by harvest time. When hatching occurred one week or more before bloom, surviving larvae bored primarily into lateral stems; however, ca. ⅓ of these larvae shifted their feeding activity to pods as they became available.

Effect of chitinase on the peritrophic membrane of *Lymantria dispar* L. (Lepidoptera: Lymantriidae) larvae. N. R. Dubois, U.S. Forest Service, Hamden, CT, H. B. Gunner, and D. A. Daoust, Dept. Environ. Sci., Univ. Massachusetts, Amherst, MA 01003

Chitinolytic microorganisms have been isolated from healthy instar III, IV and V *L. dispar* larvae. The acquisition of the chitinolytic microflora appears to be correlated with an increase of mobility by the maturing larvae. Selected isolates, two identified as *Bacillus coagulans* and two *Streptomyces* species were inducible for chitinase by the insect host tissue. Stock chitinases produced by the four isolates readily attacked the chitinous integuments of the larvae, releasing N-acetylglucosamine. *In vitro* studies showed that the peritrophic membrane was very susceptible to the chitinase. *In vivo* studies demonstrated that *B. coagulans* was lethal to the larvae when these were fed chitinase induced whole cultures of the bacteria; when the chitinase was fed with sublethal doses of *B. thuringiensis*, significant mortality was observed. When ingested, the chitinase caused localized dissolution and ulceration of the peritrophic membrane. The pH of the mesenteron appears to have a limiting effect on the *in vivo* chitinase activity on the peritrophic membrane.

Attraction of apple maggot *Rhagoletis pomonella* (Walsh) (Diptera: Tephritidae) females to apple volatiles in wind tunnel bioassays. B. L. Fein, W. H. Reissig, and W. L. Roelofs, Dept. Entomol., NYS Agr. Exp. Sta., Geneva, NY 14456

Apple volatiles from whole Red Delicious and Red Astrachan apples attracted sexually mature female apple maggot flies, *Rhagoletis pomonella*, in wind tunnel bioassays. Forty other apple varieties were tested but these were not attractive. Compressed air was passed through a desiccator filled with apples of a given variety for three days and the volatiles were trapped on a column of Porapak Q. The volatiles were retrieved for testing by rinsing the Porapak with Skelly B, and reducing the solvent volume to 1 ml, and testing 60 μl quantities. In wind tunnel tests, two pieces of filter paper were placed adjacent to one another at the upwind end of the tunnel, 36 cm apart. An aliquot of volatile extract was placed on one and an equal volume of solvent was placed on the other as a control. A perforated wax sphere was placed over each filter paper. Tests with smoke showed that non-overlapping plumes emanated from each sphere and remained coherent the length of the tunnel. Two cages, each containing fifty laboratory reared flies, were placed in the downwind end of the tunnel. The cages were aligned to be directly in the plume of the volatiles or the control. The number and rate of flies arriving and the number of flies attempting oviposition was recorded. Attractive volatile rinses were fractionated using gas-liquid chromatography. These fractions were assayed in the wind tunnel and by electroantennography. Fractions which were the most attractive in the olfactometer also elicited the highest electroantennogram responses.

Queen cell production and control in the honey bee (*Apis mellifera* L.) colony (Hymenoptera: Apidae). R. D. Fell, Dept. Entomol., Cornell Univ., Ithaca, NY 14853

The production of emergency queen cells occurs when a honey bee colony suddenly loses its queen. Young worker larvae are fed royal jelly and are reared into queens. Cell construction begins within 24 hours and continues for several days. The number of queen cells that a colony produces was found to reach a peak within 4 to 5 days and then level off as the first queen cells were capped. Usually no new cells were initiated after capped cells appeared in a hive. This reduction in the number of emergency queen cell starts was not caused by a lack of suitable worker larvae from which to rear queens; but from the presence of capped queen cells. These cells have been found to inhibit further queen cell production. The addition of young worker larvae to a queenless colony with capped queen cells did not stimulate additional queen rearing. Significant queen production only occurred if the

capped queen cells in a test colony were destroyed at the time the worker larvae were introduced. These observations are supported by the finding that the addition of capped queen cells to a recently dequeened colony will also reduce queen cell production. These results indicate that negative feedback controls queen cell production in the honey bee colony. The possibility that a queen cell pheromone is involved in the control of cell production and recognition is currently being investigated.

Contact action of diflubenzuron on eggs and larvae of gypsy moth, *Lymantria dispar* L. (Lepidoptera: Lymantriidae). A. J. Forgash, N. C. Respicio and B. K. Khoo, Dept. Entomol. and Eco. Zool., Rutgers Univ., New Brunswick, NJ 08903

The contact toxicity of diflubenzuron to eggs and larvae of the gypsy moth was investigated. Egg masses and dehaired eggs were sprayed with 2.07 FL or SULV 5% formulations at the rates of 0.067 and 0.56 kg AI/ha. Contact toxicity to larvae reared on artificial diet was determined via topical and spray applications. Third-instar larvae were treated topically with technical grade or W-25 formulation. Two formulations (2.07 FL and SULV 5%) were sprayed at the rate of 0.067 kg AI/ha on 1st to 5th-instar larvae. Toxicities were evaluated according to the number of successful molts and in the severity of the symptoms in non-surviving larvae. Treatment of eggs with both rates did not affect hatching success. In addition, the molting process of hatched larvae was not affected at the rate of 0.067 kg AI/ha. However, at the rate of 0.56 kg AI/ha, molting of hatched larvae was prevented completely. Topical and spray applications effectively prevented molting of treated larvae. Technical grade diflubenzuron was slightly more effective than W-25 formulation on 3rd-instars by topical application. Spray applications of 2.07 FL and SULV 5% formulations were also toxic to all larval instars; SULV 5% was more effective than 2.07 FL on 1st and 2nd instars. However, there were no differences in toxicity between the two formulations on the older instars. These results established the effectiveness of diflubenzuron on gypsy moth via cuticular penetration and indicate that there may be other species that are equally susceptible to this material by contact.

The structure and dynamics of arthropod communities of bat guano ecosystems. E. R. Franklin and T. H. Kunz, Dept. Biol., Boston Univ., Boston, MA 02215

The objective of this study was to characterize the composition, structure, and dynamics of arthropod communities associated with bat guano deposits in buildings. Three sites in New Hampshire were sampled from February 1977 through January 1978. Twelve species are reported including three Coleoptera, one Siphonaptera, two Hemiptera, two Psocoptera, three Acarina, and one Pseudoscorpion. Most are cosmopolitan associates of dried organic matter. These communities exploit a seasonally rich food source produced by roosting bats. Seasonal community changes included the presence of fleas only when bats were present, more arthropod species but a lower species diversity when bats were present, and a more equitable distribution and abundance of species when bats were absent. Older communities and those with the most diverse resource base generally supported the most species. There was evidence of the following species interactions: 1) an adverse effect of predatory bdellid mites on flea larva density, 2) predation of mealworms and flea larvae by the masked assassin bug, 3) decreases in fungivorous mite density corresponding with increases in density of mealworms and dermestid larvae, and 4) a fungivorous mite, predatory mite, pseudoscorpion food chain.

Esterase variation in female *Aedes aegypti* (Diptera: Culicidae): Isozyme characterization and the influence of adult ageing. D. J. Fryauff and D. J. Sutherland, Rutgers Univ., New Brunswick, NJ 08903

Soluble esterase components of female *Ae. aegypti* were resolved through conventional polyacrylamide gel electrophoresis of pooled whole body homogenates. Using a staining reaction that employed the general esterase substrate 1-naphthyl acetate, enzyme activity of pupae and adults was revealed colorimetrically and assessed by densitometry. Subclass and isozyme characterization of esterases as either carboxylesterase (E.C.-3.1.1.1), arylesterase (E.C.-3.1.1.2), or cholinesterase (E.C.-3.1.1.7) was based on comparative inhibition of activity by the specific esterase inhibitors dichlorvos (DDVP), and eserine. Of 9 migrating bands detected in pupae, 6 were characterized as isozymes of carboxylesterase, 2 as arylesterases, and 1 as cholinesterase. More than 90% of the pupal activity was concentrated in the 4 leading carboxylesterases. Newly emerged imaginal mosquitoes contained 11 esterase components with relative activities and banding patterns similar to those of pupae. During the course of emergence an arylesterase was lost and additional carboxylesterase components became apparent in adults. However, combined activity of all adult esterases had declined significantly

from those levels recorded for pupae. Maximum activity of adult esterase, recorded within 48 hours, declined rapidly after 72 hours. This decline was attributed to the (1) reduction in number, and (2) diminished activity of the 4 leading carboxylesterase isozymes. Conversely, cholinesterase, which had contributed insignificantly to the total activity in pupae rose sharply to account for 8% within 6 hours of emergence and continued to register high activity over 14 days of ageing.

A hypothesis for the distribution of holarctic groups of fungus gnats (Diptera: Mycetophilidae). R. J. Gagné, Systematic Entomology Lab, FR, SEA, USDA, Washington, DC 20560

Recent revisions of Mycetophilidae show patterns of holarctic distribution that are repeated many times. These flies are evidently very ancient in that many holarctic genera are represented on the southern continents by vicariant genera. In the holarctic region, most genera, subgenera, and species groups have one or more species that occur in both Europe and North America, one or more that are strictly nearctic, and one or more strictly palearctic. Although most species that occur in North America are widespread from coast to coast, some occur only in the Great Plains eastward, others only in the Rocky Mountains westward. Many of the eastern nearctic species occur in Europe, but none of the exclusively western species do. These patterns are not explained by dispersal via Beringia or by separation due to Pleistocene glaciation. The most likely hypothesis for this particular distribution must take into account the early Eocene land connection between eastern North America and Europe. Species presently ranging throughout the holarctic region are probably virtually unchanged since before the breakup of Laurasia and those species limited to Europe and eastern North America unchanged since the early Eocene when those 2 areas were one continent separated from western North America and Asia by seas. Species restricted to eastern North America resulted some time after the breakup of Euramerica in the middle Eocene. This supposes a very ancient age for extant species of fungus gnats, but that conclusion is supported by the fossil record.

Temporal patterns of parasitization of face fly (Diptera: Muscidae) by *Thelazia* sp. (Bosc) (Nematoda: Spirurata) on three dairy farms in Western Massachusetts. C. J. Geden and J. G. Stoffolano, Jr., Univ. Massachusetts, Amherst, MA 01003

Two species of nematode bovine eyeworms of the genus *Thelazia*, *T. gulosa* and *T. skrjabini* have been recovered from the eyes of slaughtered

cattle in Massachusetts while a survey during the summer of 1976 showed that of eighteen face fly populations sampled in the state, all contained some members parasitized by immature forms of the parasites. Because of the potentially serious veterinary and economic hazards presented by this group of eyeworms and the scarcity of basic information on the life history of the worms, a study was conducted to determine what temporal patterns of parasitization may be present in the intermediate host. To this end three herds of dairy cattle, all Holsteins from Western Massachusetts, were selected, from which female face flies were collected and dissected throughout the summer of 1977. On all three farms a first peak of infection in the flies was observed at about June 20, followed by a decline in early to mid-August, then an increase to a second peak in early September. These patterns may be due to the biology of the parasites, the age structure of the fly populations or to a combination of these factors.

Emigration behavior of the East African driver ant, *Dorylus (Anomma) molesta* Gerstaecker (Hymenoptera: Formicidae: Dorylinae). W. H. Gotwald, Jr., Utica College of Syracuse Univ., Utica, NY 13502

Emigration behavior of *Anomma* driver ants and of Old World army ants in general is poorly known. Theoretically, army ants are defined as nomadic, since the most thoroughly studied species periodically emigrate from one nesting site to another. In order to better understand army ant emigration behavior, a study of *D. (A.) molesta* was conducted from July 1971 through December 1973 on a research area of approximately 5 hectares near Nairobi, Kenya. A total of 100 emigrations conducted by 15 colonies were observed and 39 nest sites located and described. One colony emigrated 40 times and was under continuous observation for 432 days. The most extensively used nest site was occupied on 15 separate occasions by 4 different colonies. Specific nest sites were occupied by some colonies for as few as 3 days and as many as 67 days. The following can be concluded: (1) emigrations occur at irregular intervals, indicating that the behavioral stimuli for emigrations do not reside in the colony's reproductive cycle; (2) emigrations often take place over short distances and may not significantly change the colony's trophophoric field; and (3) many emigration trails and nest sites become permanently established and can be reused by a single colony or used and occupied sequentially by several different colonies.

Differences in maze-learning ability in two species of lepidopteran larvae. S. T. Grant, Zool. Dept., Univ. Massachusetts, Amherst, MA 01003

Larvae of *Vanessa cardui* L. (Lepidoptera: Nymphalidae) and *Danaus plexippus* L. (Lepidoptera: Danaidae) were trained in T-shaped mazes which incorporated electric shock as negative reinforcement for entering the wrong arm of the maze and food reward for entering the correct arm. All larvae were trained daily for one-hour periods, during the fifth larval instar, after a ten to twelve-hour period of food deprival. The *V. cardui* larvae showed progressive improvement in their performance during training but the *D. plexippus* larvae did not. Latency to the first completed run was significantly lower in *V. cardui* larvae, and the rate at which larvae re-entered the choice point of the maze following encounter with the shock device was significantly higher in *V. cardui*. The two species of Lepidoptera studied differ in their larval ecology, with *V. cardui* caterpillars being polyphagous, cryptically colored, and prone to defoliate their foodplants, while *D. plexippus* caterpillars are oligophagous, aposematically colored, and not prone to defoliate their foodplants. It is concluded that the ecological differences between the two speices helps to account for their differing abilities in maze-learning, as the *V. cardui* larvae would be pre-adapted for active exploration of their environment.

Courtship of the brown-banded cockroach, *Supella longipalpa* (Blattaria: Blattellidae). R. S. Grippo and I. Huber, Dept. Biology, Fairleigh Dickinson Univ., Madison, NJ 07940

Courtship of *Supella longipalpa* (F.) is similar to that of the German cockroach: antennal fencing, male raises wings and rotates 180° to face away from female, female mounts and feeds on male's exposed tergal glands, male grasps female's genitalia with his and pair assume an opposed linear (copulatory) position facing away from each other. In *Supella*, mutual antennal fencing is not a necessary releaser for the male to continue his courtship sequence as it is in the German cockroach. Also, wing-raising precedes rotation whereas these are simultaneous in *Blattella germanica*. The virgin male does not show a positive response, as indicated by wing-raising, to contact with a virgin female until 6 d. after adult ecdysis. The percent males responding increases to a maximum on the 10th and 11th days and is slight after the 17th day. The time needed to elicit a courting response in the male after initial contact with a virgin female was shortest from the 9th through 11th days. Morphological evidence indicates that a primitive blattellid such as *Supella* is a more likely ancestor of the internal-incubating cockroaches (Blaberidae), than is a blattelline such as *Blattella*. Thus, further study of courtship, pheromones and mating in *Supella*, a member of the previously

unstudied subfamily Plectopterinae, should be important in understanding these phenomena in the Blaberidae as well as aiding in the development of methodologies for the disruption of mating in this pest species.

Changes in food quality of an insect's marginal host species associated with a plant virus. J. D. Hare and J. A. Dodds, Connecticut Agric. Exp. Stn., New Haven, CT 06504

The ecological relationships between insects, plants, and plant viruses are poorly understood. Although changes in several physiological functions of plants caused by plant viruses have been described, their effects on other species, such as herbivores, are virtually unknown. Most varieties of the cultivated tomato, *Lycopersicum esculentum,* are poor hosts for the Colorado potato beetle, *Leptinotarsa decemlineata.* However, when tomato plants are inoculated with either a mild (nearly symptomless) or a severe (symptomatic) strain of tobacco mosaic virus, insect survival is significantly greater. Analyses of leaf tissue show that the total organic nitrogen content of virus-infected plants is up to 40% greater than virus-free plants, and most of this difference can probably be attributed to the presence of viral protein in infected leaf tissue. Recent studies with other plant-insect associations have shown that plant nitrogen content is one of the more important factors governing insect growth, and further experiments are in progress to ascertain if the major differences in plant nutritional quality are the result of virus induced increases in total leaf protein. These results call into question the advisability of using mild strains of plant viruses to confer immunity to more severe strains, and they raise several questions concerning the differential utilization of individual plants of marginal host species and their role in the dynamics of phytophagous insect populations.

Dusky sap beetle *Carpophilus lugubris* (Coleoptera: Nitidulidae): Control in sweet corn. F. P. Harrison and J. C. Richardson, Dept. Entomol. Univ., Maryland, College Park, MD 20742

Since 1959 a screening program for control of insects attacking sweet corn ears has been conducted in order to evaluate promising compounds. Carbaryl was used in all these tests as the standard comparison material. After examining the effect of spraying ears with carbaryl over many years, it is apparent that the results obtained with this material against dusky sap beetle was unpredictably erratic. These data were examined from more than one aspect. The results of examing these data indicated that the presence of corn earworm was apparently associated with significant control of dusky sap beetle. Also, secondary infestation, that sap beetle infestation that at-

tacks ears that are injured by another insect, was the infestation that was significantly reduced. A series of experiments was conducted in order to determine techniques that would be effective in reducing primary infestations. Plots of sweet corn were planted in series in 2 consecutive years. Plots were divided into 4 sub-plots receiving 0, 1, 2 and 3 applications of 2 lbs. carbaryl each in 25 gallons of water per acre. Observing results of these experiments indicated that primary infestation (ears infested with dusky sap beetle alone) required a greater number of applications of carbaryl than secondary infestation.

The insects important in no-till corn in Maryland and their control. F. P. Harrison, A. Bean and O. J. Qawiyy. Univ. Maryland, College Park, MD 20742

A survey of the soil-borne insects damaging corn in Maryland indicated that cutworms and armyworms were significantly more injurious in no-till corn than in conventionally tilled corn. Because the producers of sweet corn grown for processing have experienced yield losses in recent years and these yield reductions are mainly attributed to moisture stress, there is some interest within the processing industry in growing no-till sweet corn, the idea being that no-till provides a degree of moisture conservation. Because a no-till culture encourages attacks by cutworms and armyworms, a series of experiments were conducted from 1975 through 1978 to evaluate techniques for reducing losses by cutworms and armyworms. The sweet corn was grown using rye as a cover. In the spring this cover is killed with a contact herbicide in combination with preventive herbicides. Corn seed is then planted through this cover. The cover mats down and provides a mulch which conserves moisture and provides optimum conditions for some insects. These experiments evaluated a number of insecticides applied as banded planter applications and as broadcast sprays. In 1975 and 1976 the losses were from armyworm. In 1978 black cutworm caused stand reduction. Chlorpyrifos 15G, carbofuran 10G and Dyfonate 20G were effective against armyworm. Chlorpyrifos 15G and 4E and Nematak 2L were effective against black cutworm.

The origin of the cell lining in the nests of *Colletes* bees (Hymenoptera: Colletidae). A. Hefetz, Laboratory of Chemistry, National Heart, Lung, and Blood Inst., Bethesda, MD 20014, and S. W. T. Batra, Beneficial Insect Introd. Lab. USDA, MD 20705

The Dufour's gland, associated with the sting apparatus, is very large in bees of the genus *Colletes*. It is filled with oily, odoriferous material and

occupies most of the abdomen. Since these ground dwelling bees utilize their sting when lining their brood cell, it was interesting to compare the chemistry of their glandular content with that of the cell lining. Dufour's glands of three species, *C. thorncicus*, *C. validus* and *C. inequalis*, were extracted in methylene chloride and analyzed by a combined gas chromatography-mass spectroscopy, utilizing an SE-30 capillary column. The major components of the glands are a homologous series of macrocyclic lactones, hexadecanolide, octadecanolide, eiscosanolide and docosanalide. An unsaturated lactone, octadecanolide also appears in appreciable amounts. Accompanying these lactones are high molecular weight hydrocarbons and an unidentified compound. The cell lining in the nests of the bees is a white membrane, only slightly soluble in methylene chloride. Analysis of the soluble fraction revealed the presence of the lactones characteristic to the Dufour's gland, as well as the unidentified component. These results suggest that the bees use the content of their Dufour's gland for lining their cells. The origin of the insoluble material in the cell lining is still unknown, but it is possible that the corresponding hydroxyfatty acids, form polyesters rather than lactones, thus creating a waterproof lining.

Feeding activity of the alfalfa blotch leafminer, *Agromyza frontella* (Rondani) (Diptera: Agromyzidae). R. G. Helgesen and F. Baxendale, Cornell Univ., Ithaca, NY 14853

In developing a pest management program for the alfalfa blotch leafminer, it was necessary to quantify the age-specific feeding activity of the miner because our simulation models function on an age-specific, continuous basis. The alfalfa blotch leafminer feeds on its side in a sickel-like fashion consuming the entire mesophyll of the alfalfa leaflet. The larva leaves behind it three chracteristic frass patterns conveniently corresponding to each larval instar. The first instar larva forms a linear mine with frass laid in two parallel rows, the second instar larva produces a transitional mine with frass laid in semi-circular arcs and the third instar larva forms a blotch mine with amorphous frass oriented to the center of the blotch. Newly hatched larvae usually feed toward the margin between the veins of the leaflets and then turn toward the center of the leaflet to form the blotch. We photographed completed mines, enlarged them 10× and, with a polar planimeter, measured the area consumed during each larval stage. We found that the area of leaflet consumed was a) ca 2.5 mm^2 in the first instar, b) ca 10 mm^2 in the second instar and, c) ca 45 mm^2 in the third instar producing a complete mine of ca 60 mm^2. We assumed the feeding rate was an increasing exponential function with regard to age. Using this model we found that we could express the age specific feeding rate (y) as: $y = e^{.03x}$ and cumulative feeding (z) as: $z = e^{.041x}$, where x is percent development.

Establishment of *Dacnusa dryas* (Nixon) (Hymenoptera: Braconidae) and *Chrysocharis punctifacies* Delucchi (Hymenoptera: Eulophidae), parasites of *Agromyza frontella* (Rondani) (Diptera: Agromyzidae) in Delaware. R. M. Hendrickson, Jr., USDA-SEA-FR, Benef. Ins. Res. Lab., 501 S. Chapel St., Newark, DE 19713

These European parasite species were released in 1977 at the laboratory alfalfa field. A total of ca 600 *D. dryas* were released against the 1st-, 2nd-, and 3rd-host generations, and a total of ca 200 *C. punctifacies* against the 2nd- and 3rd-host generations. Both species were recovered by sweeping during the 1st- and 2nd-host generations in 1978. Maximum recovery rates were 20 per 100 sweeps for *D. dryas*, and 1 per 100 sweeps for *C. punctifacies*. Both species have been released in small numbers in 4 other states: New Jersey, Pennsylvania, New York, and Ohio. Recoveries have been made only from Delaware where large releases and extensive recovery surveys were made. These species oviposit on larvae and emerge from puparia. The USA has no effective native parasite species which emerge from puparia. In contrast, *D. dryas* and *C. punctifacies* accounted for a combined 21% parasitism (from 33,573 puparia shipped to Newark, Del., by the USDA European Parasite Laboratory in 1976–77). Since season-long parasitism of *A. frontella* by all native parasite species averaged 36% for 1975–77, the addition of these 2 European species to the native complex may raise total parasitism to 50–60%, perhaps enough to reduce *A. frontella* populations below an economic threshold.

Acoustical communication during courtship and mating in green lacewings (Neuroptera: Chrysopidae). C. S. Henry, Univ. of Connecticut, Storrs, CT 06268

Courtship and mating of the green lacewing *Chrysopa carnea* Stephens are described in detail. Copulation is preceded by 5 well defined activities; search, antennal contact, mouthpart contact, abdominal approach, and abdominal contact. Rhythmic vibration or jerking of the abdomen in the vertical plane accompanies all stages of courtship in both sexes. Isolated, sexually receptive individuals release long sequences of discrete, short volleys of abdominal vibration or jerking separated by 1 to 2 sec intervals; female solos are rarer than male solos and display significantly longer intervals between bursts than do the latter. Sexually receptive heterosexual pairs of lacewings establish duets of precise reciprocal abdominal jerking between partners; these calls seem like interdigitated solo calls, with each partner

altering its normal interburst interval slightly toward that characteristic of the opposite sex. While each solo sequence typically displays increasing and then decreasing burst intervals, successful heterosexual duets manifest ever increasing burst spacing until terminated by copulation. A pair of sexually receptive males can also establish a duet of reciprocal abdominal jerking. Airborne sound, possibly ultrasound, is used for intraspecific communication. Two lacewings that occur sympatrically with *C. carnea* similarly jerk their abdomens spontaneously and in heterosexual duets, but differ from it markedly in the temporal patterning of their volleys: *C. rufilabris* Burmeister releases sustained, modulated bursts of jerking at 10–12 sec intervals, while *C. oculata* Say produces simple long sequences of closely spaced volleys of abdominal vibration. I postulate that acoustical communication in chrysopids is a short distance phenomenon that functions primarily to isolate reproductively species that are morphologically and ecologically similar.

Two sex attractants for male speckled green fruitworm moths, *Orthosia hibisci* Guenee (Lepidoptera: Noctuidae). A. S. Hill and W. L. Roelofs, NY Sta. Agric. Exp. Stn., Geneva, NY 14456

Male *Orthosia hibisci* moths, collected from blacklight traps, were used for screening series of monounsaturated, straight-chain 12-, 14- and 16-carbon acetates, alcohols and aldehydes for electroantennogram (EAG) responses. (*Z*)-9-Tetradecenal (*I*) produced the highest EAG response, followed by (*E*)-12-tetradecenal. *I* and (*Z*)-9,(*E*)-12-tetradecadienal (*II*) each produced about equally high EAG responses. *I* and *II* were tested in the field, alone and in a 1:1 combination, at various dosages (totals of 20, 60, 200, 600, and 2000 μg) on rubber septa in Pherocon 1C traps. The highest dosage resulted in the highest trap catches and, as the dosage diminished, so did trap catches. *I*, *II*, and *I* + *II* were about equally effective at any given dosage. As many as 60 moths were caught in one trap at one time. Catches of 20–40 moths/trap/night were seen frequently with 300 μg *I* + 300 μg of *II*, which was used in 1978 by workers in the area for monitoring this insect. Other insects were not seen in consistent numbers in any of the traps used. No work has been done as yet with the female moths to identify the natural sex pheromone of *O. hibisci*. However, the EAG screening technique used, which required less than 10 moths, resulted in the rapid selection of two effective sex attractants for male *O. hibisci* in the field.

Kairomone of *Tetranychus urticae* (Acarina: Tetranychidae) influencing host-searching behavior of its predator, *Amblyseius fallacis* (Acarina: Phytoseiidae). R. G. Hislop, N. Alves and R. J. Prokopy, Dept. of Ent., Univ. Massachusetts, Amherst, MA 01003

A. fallacis is a predator of phytophagous mites in eastern North American apple orchards. In early summer it invades the trees, often borne there by wind currents. It may either remain for some time searching for prey, or soon depart to search for prey elsewhere. This choice may depend on the frequency of contact with prey. We examined the possible influence of chemical cues deposited by *T. urticae* on the host-finding behavior of *A. fallacis*. First we allowed *T. urticae* adults to infest 2-cm diameter filter paper discs for 2 days, after which we removed all stages. Then we allowed free access to such discs by starved female *A. fallacis*. The predators remained on discs over 4 times longer than on control discs having no previous exposure to *T. urticae*. Using various solvents we made extracts of discs previously infested by *T. urticae*, applied the extracts to fresh discs, and allowed starved female *A. fallacis* free access to the discs. The predators visited the discs treated with methanol extract more than twice as often as check discs (methanol alone). Also, time spent between visits to methanol-treated discs was only one-third that time between visits to check discs. These data indicate that *T. urticae* secretes chemicals which function as kairomonal cues to host-seeking *A. fallacis* females.

Synthetic pyrethroids to control insect pests of vegetable crops. R. N. Hofmaster and J. Francis, Virginia Truck and Ornament. Res. Stn., Painter, VA 23420

The synthetic pyrethroids, Pounce, Ambush and Pydrin along with the pyrethroid analog, FMC45498, were evaluated as foliage sprays against insect pests of sweet corn, collards and Irish potatoes. The following results were obtained: SWEET CORN—Fall armyworms, *Spodoptera frugiperda* (J. E. Smith) caused 100% loss of untreated ears in N&K 199 sweet corn. Applying 5 treatments of Pounce, Pydrin or Ambush at 2–3 day intervals following first silk gave 90% or better undamaged ears at a rate of 0.1 lb active/acre and virtually 100% control when the dosage was increased to 0.2 lb active/acre. The analog, FMC45498, gave comparable results at only 1/10 the above rates. COLLARDS—Cabbage looper, *Trichoplusia ni* Linn., infestations averaged nearly 30 loopers/collard plant in late August. Following a series of 3 foliage sprays, populations were reduced over 97% by Pounce, Pydrin and Ambush at 0.05 lb active/acre and FMC45498 at 0.01 lb active/acre. Especially interesting was the increase in control generated by combining 0.25 lb Dipel with 0.005 lb Pydrin/acre. *IRISH POTATOES*—

Beet armyworm, *Spodoptera exigua* (Hubner) and European corn borer, *Ostrinia nubilalis* (Hubner) damage was reduced at least 95% by foliage sprays of Ambush, Pounce or Pydrin applied at 0.1 lb active/acre in a 7–10 day schedule. Beet armyworm infestations averaged 18/hill and corn borers 22.5/hill in the untreated check. The synthetic pyrethroids, Pounce, Ambush and Pydrin together with the analog FMC 45498 offer a potentially valuable means of control of hertofore troublesome vegetable insect pests.

Introducing integrated control in Virginia apple orchards: Techniques for involving and training growers. R. L. Horsburgh, Shenandoah Valley Res. Sta., VPI & SU, Steeles Tavern, VA 24476

The wide geographic separation and small acreage of apple orchard blocks in central Virginia make private commercial consultation in pest management relatively unattractive economically. Therefore, attempts were made to improve grower capabilities of pest recognition and pest population monitoring during the early growing seasons of 1976, 77, and 78. The technique employed was that of holding weekly in-orchard training sessions that extended over the noon hour. In 1976, 17 such meetings were held, 24 in 1977 and 27 in 1978. Grower capabilities have definitely improved and an integrated control program was commenced in seven commercial orchards in 1978. Other extension objectives have been realized through the utilization of this technique, including familiarization of extension of personnel with local pest problems on a regular basis; dispersal of timely information on a variety of orchard related subjects; routine problem solving and graduate student training under commercial orchard conditions. Interest of fruit producers has been maintained and intensified because the topics discussed each week are directly related to their own commercial orcharding methods. Furthermore, the problems are observed under genuine commercial conditions instead of a less typical research situation.

Potato leafhopper density and its relationship to alfalfa quality. A. A. Hower, The Pennsylvania Sta. Univ., University Park, PA 16802

Studies were conducted in various regions across Pennsylvania in order to characterize the population densities of potato leafhoppers and to determine corresponding losses in alfalfa quality. Leafhopper numbers at the population peak on a crop ranged from a low 0.6 per sweep in northeastern counties to a high 156 per sweep in the southeast. During 2 years the relationship between leafhopper numbers and reduction in % crude protein appeared nonlinear. A density of 2 leafhoppers per sweep caused an average

2% loss in protein while 50 and 100 leafhoppers per sweep accounted for losses of 5.8 and 7.0 percent, respectively.

A field cage study was initiated to more precisely identify the amount of damage caused by leafhoppers developing on an individual alfalfa stem. Leafhoppers were caged as 1st instar nymphs on 22.9 cm tall alfalfa. A density of 1–2 nymphs per stem reduced crude protein an average 3% on 2nd and 3rd crop alfalfa. Protein declined an average 4–5% on both crops where leafhoppers numbered 3–4 per stem. Alfalfa height and weight also were negatively influenced under leafhopper stress. Dry weight losses exceeded 24% when 3 or more nymphs were allowed to develop to adults on one stem. Additional field and laboratory studies are being continued to more precisely identify the above relationships.

Hemocytes, cell death, hemolymph coagulation and melanization in insects. J. C. Jones and R. J. Ruschell, Jr., Univ. of Maryland, College Pk., MD 20742

The hemocytes of four species of insects belonging to four orders of insects were studied in relation to cell death, gelation and melanization of the hemoplasma in unfixed whole hemolymph. In *Acheta domesticus* adults, almost all of the hemocytes rapidly disintegrated (their nuclei remained intact) and there was an intense precipitation of the hemoplasma. The hemolymph turned a light gray. In mature *Musca domestica* and *Manduca sexta* larvae only a few hemocytes disintegrated and none of the hemocytes themselves darkened, yet the hemoplasma turned dark and gelled. Gelation of the plasma in mature *Musca* occurred in the absence of podocytes. In mature *Apis mellifera* larvae, only a few hemocytes and fat body cells were seen in the hemoplasma; none lysed; none darkened. The plasma did not gel or darken *in vitro*. It is concluded that while cell death may be associated with plasma coagulation it is not associated with melanization.

Experience with grape pest management in Erie County, Pennsylvania. G. L. Jubb, Jr., T. H. Obourn, and D. H. Petersen. Pennsylvania State Univ. North East, PA 16428.

A pilot pest management program for grapes was tested in Erie County, Pennsylvania, during the summers of 1976–78. Nine growers participated in 1976 (135.6 ha), 14 growers participated in 1977 (214 ha), and 16 growers participated in 1978 (224.8 ha). Vineyards were scouted weekly for 15 weeks beginning on June 1. Fees of $3.00 and $4.75 per 0.4 ha were assessed to

participants in 1977 and 1978, respectively, to help offset costs of the program. Scouts reported insect and mite pest counts to each grower the day their vineyard was inspected. Growers made the final decision on the need to apply pesticides. Insect and mite damage in pest management vineyards was generally light each year. Pests requiring post-bloom sprays in several vineyards were grape leafhopper, grape berry moth, grapevine looper, and European red mite. Participants reduced their post-bloom insecticide sprays as compared to non-participants. Average number of post-bloom insecticide applications in 1976 was 2.5 for non-participants and 0.8 applications for participants and in 1977 was 2.3 applications for non-participants and 1.1 applications for participants. Potential savings in spray costs, depending on materials used, ranged from $7–12 per 0.4 ha in the pest management program. Scouting costs were $4.42 per 0.4 ha in 1976 and $4.63 per 0.4 ha in 1977. Grower opinion of the program was quite favorable. Most growers would like to see the program continued and indicated a willingness to pay a higher seasonal fee.

Estimation of esterase activity in gypsy moth, *Lymantria dispar* L. (Lepidoptera: Lymantriidae) larval tissues. M. A. Kapin and S. Ahmad, Dept. of Entomol. & Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Esterases (EC 3.1.1.) in insects are implicated in the regulation of JH titer, catabolism of fats, cuticular wax synthesis and transport, degradation of undesirable dietary esters, and insecticides. This report relates to our current work on the nature of these enzymes in gypsy moth larvae. Homogenates of fifth-instar tissues were centrifuged at $12000 \times g$ to obtain clear supernatants as enzyme sources. 1-Naphthylacetate was used as a substrate, which upon enzymic hydrolysis produces 1-naphthol. This product when coupled to a diazo dye, Fast Blue B, produces a blue color that is estimated spectrophotometrically at 590 nm. By this method, relative specific rates and distribution of esterase activity (in parentheses) in larval tissues, excluding hemolymph, were initially estimated as follows: 100 (95.9), 9.7 (1.6), 5.4 (0.2), 2.7 (0.4), 2.0 (1.7), 1.7 (0.1), 1.3 (<0.1), and 0.8 (<0.1) percent in midgut, foregut, gonads, hindgut, brain, Malpighian tubules, nerve cord, and muscles, respectively. Thus, the principal site of esterases in gypsy moth larvae is the midgut, showing the highest concentration (specific activity, 2.9 μmoles mg^{-1} min^{-1} at 24°C) of esterases ever recorded in an insect species. Also, the midgut preparation is fairly thermostable (optimum range 45°–50°C for 20 min.) and can be stored over 24 h at −15°C without any loss in enzyme activity. Further characterization of esterases is in progress.

Basic studies of chiasma frequency in male *Blattella germanica* (Dictyoptera, Blattellidae). C. B. Keil, VPI & SU, Blacksburg, VA 24061.

This investigation represents the first examination of chiasma frequency in a primitive orthopteroid insect, *Blattella germanica*. The data obtained are useful both in advancing our knowledge of cockroach genetics and in stimulating comparative cytogenetic studies. Experimental animals were reared in a constant temperature and humidity chamber and segregated according to whether they emerged from a first, second, or third ootheca. The testes of 3rd to 4th instar male nymphs were removed, stained with acetic orecien and examined for suitable numbers of primary spermatocytes at diakinesis. Analysis of the chiasma frequency data showed a slight decrease in the mean number of chiasma per bivalent; 1.3325 ± 0.0385 for 1st ootheca cockroaches, 1.3002 ± 0.0371 for 2nd ootheca cockroaches, and 1.2950 ± 0.0346 for 3rd ootheca cockroaches. The variances of the groups decline with the means. Bartlett's test for homoscedasticity showed these variances to be drawn from statistically different populations ($P < 0.05$). The chiasma frequency of a stock heterozygous for a reciprocal translocation involving two mid-sized chromosomes, 8 and 9, was compared to the wild type frequencies. I found an elevated chiasma frequency, 1.4185 ± 0.0190 chiasma per bivalent, in comparison to the first ootheca group. This figure is within values expected if a double chiasma event in either bivalent 8 or 9 in wild type cockroaches is assumed to occur in the majority of primary spermatocytes. In comparison with the 1st ootheca data the variance of the translocation stocks' chiasma frequency is greatly reduced. This reduction may be due to a compression of the frequency distribution upon a mechanical upper limit.

Induction of multiple progeny emergence of the gypsy moth parasitoid, *Brachymeria intermedia* (Nees) (Hymenoptera: Chalcididae) by Dimilin®. B. K. Khoo, S. B. Ramaswamy, N. C. Respicio, and A. J. Forgash, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903.

The effect of Dimilin® (diflubenzuron) on adult *Brachymeria intermedia* (Nees) was investigated. Initially, female and male adults were topically treated with 2.0 or 4.0 μg diflubenzuron. Treated parasites were held for a minimum of 6 days before each mated female was provided with a gypsy moth pupa for 24-h oviposition. Both treatment levels of diflubenzuron induced emergence of multiple progeny. As many as 14 parasites emerged from a single host. There was great variation in the size of the F_1 progeny. This may be related to difference in hatching time of the oviposited eggs and nutrient supply of the host during parasite development. Diflubenzuron has no adverse effect on the parasitization capacity of the parents nor the

F_1 progeny, and its inductive effect was not carried over to the F_1 generation. It was determined that only female *B. intermedia* need be treated and that a virgin state is not a prerequisite for multiple progeny induction. By varying the intervals between diflubenzuron-treatment and the providing of hosts to the treated females, it was found that a holding time of a minimum of 4 days was necessary for manifestation of multiple progeny emergence. Diflubenzuron also induced multiple progeny emergence in *Brachymeria lasus*, an exotic relative of *B. intermedia*, with no apparent effect on its parasitization capacity or on that of the F_1 generation.

Resource availability and reproductive variation in *Pseudeucoila* spp. (Hymenoptera: Cynipidae). A. Kopelman and P. C. Chabora, Queens College, Flushing, NY 11367

Theory regarding reproductive plasticity as an adaptive strategy has recently emerged and here is investigated in a parasite-host relationship. Individual females were presented excess host (*Drosophila melanogaster*) larvae in three schedules: a) constant exposure to hosts throughout life, b) exposure to hosts for 24 h every third day, c) daily exposure for 1 h throughout life. When without hosts, parasites were kept in vials with host medium and honey. Two patterns of progeny production emerged. 1) With continually available hosts (schedule a), early "explosive" reproduction was followed by an extended period of post reproductive survival. By day 5 about 95% of all female progeny were produced and the sex ratio changed from 0.31 ± 0.04 on day 1 to 0.72 ± 0.16 on day 5. After the last female offspring, males were produced for 4 days prior to a post reproductive period of 9.6 ± 0.89 days. 2) With limited host availability (schedules b and c) reproduction was maintained for all but the last day of life. Female progeny were produced throughout the reproductive period with 95% being produced in 10 days. Sex ratios increased to a maximum of 0.92 and 0.59 for exposure schedules b and c, respectively, on the last day of reproduction. Survivorships were similar between exposure schedules. Reproductive strategies in unpredictable environments show increased survivorship at the expense of reproductive output. The patterns suggested here show that potential longevity affords maximal opportunity for parasitism when hosts are patchily distributed, yet allows opportunistic exploitation when hosts are abundant. (Supported by BHE-PSC Grant No. 10189 to P.C.C.).

Physical and chemical defenses of the salt marsh shrub, *Baccharis halimifolia* L. (Compositae) against insect herbivory. S. K. Kraft and R. F. Denno, Dept. Entomol., Univ. Maryland, College Park, MD 20742

Baccharis halimifolia leafs out in early spring and shows an increase in leaf biomass throughout the growing season. Leaf drop occurs in late fall. *Trirhabda baccharidis* (Weber) (Coleoptera: Chrysomelidae), a univoltine, monophagous species, and the dominant herbivore on *B. halimifolia*, feeds only during spring and early summer. *B. halimifolia* is free of most insect herbivory during summer and fall. This research explores the defensive syndrome of *B. halimifolia* which is apparently effective during much of the growing season.

Leaves increase in toughness and decrease in moisture as the growing season progresses. When simultaneously offered various age (toughness)-classes of leaves, larvae of *T. baccharidis* fed primarily on young, tender leaves. Also, larvae fed young, tender leaves ultimately weighed more, pupated earlier, and incurred less mortality than those fed older leaves. *T. baccharidis* larvae showed no apparent feeding preference for similarly tough *B. halimifolia* leaves painted with differing concentrations of late season acetone and ethanol leaf extracts. Elm leaves painted with the same *B. halimifolia* leaf extracts were avoided by larvae of the elm leaf beetle, *Pyrrhalta luteola* (Muller) (Chrysomelidae). Control leaves painted with pure solvents were readily eaten.

These results suggest that the adapted specialist *T. baccharidis* is able to tolerate secondary chemicals, over the concentration range that we examined, and that leaf toughness is the primary factor that dissuades its feeding. However, secondary chemicals present in the leaves of *B. halimifolia* may be effective in preventing herbivory from other insects.

Effects of field application of gypsy moth *Lymantria dispar* L. (Lepidoptera: Lymantriidae) nucleopolyhedrosis virus (Baculovirus) on birds. R.A. Lautenschlager,[1] J.D. Podgwaite[1] and H. Rothenbacher,[2] U.S. For. Ser., Northeastern For. Exp. Stn.,[1] Hamden, CT 06514 and Dept. Vet. Pathol. Pennsylvania State Univ.,[2] University Pk., PA 16802.

Wild songbirds and caged quail, *Colinus virginianus* (L.) were studied to detect any short-term adverse effects resulting from the aerial application of nucleopolyhedrosis virus (NPV) for gypsy moth control on woodland plots in central PA. NPV was used in two formulations and applied at the rate of 2.5×10^{12} polyhedral inclusion bodies (PIB)/ha. Singing male territory-mapping census techniques were used to determine demographic changes in resident songbird populations. Analysis of pre-spray and post-spray censuses on NPV-treated and control plots indicated that there were

no short-term population changes that could be attributed to NPV treatments. Necropsy and histopathological data were taken on 23 quail that had been caged on the study plots for 3 weeks following NPV application. Similar data were taken on 53 songbirds that were collected from the study plots over a 10-week period following NPV application. Analyses of these data indicated that there were no significant differences between control and treated birds that could be ascribed to the NPV application.

Flight periods of *Orthosia hibisci* Guenee (Noctuidae: Lepidoptera) in relation to the calendar, temperature and host development. S. E. Lienk and P. J. Chapman, NYS Agric. Exp. Sta., Geneva, NY 14456

Of the green fruitworms that feed on the young fruits of apple and pear in the northeastern quadrant of the United States and in the adjoining provinces of Canada, *O. hibisci* is the commonest species. It overwinters in the pupal stage. Based on records obtained from two (one in 1974) walk-in blacklight traps at Geneva, NY a few adults may be recovered some seasons in March but the main flight occurs in April and May. In 1974, 50% of the seasons' catch was taken by April 26; by May 4 in 1975; by April 17 in 1976; by April 16 in 1977; and by May 11 in 1978. The five year catch of *O. hibisci* adults totaled 3250. Flight was induced when maximum-minimum temperature means of 7°C (45°F) and higher prevailed. Between the years, no agreement was found between key fractions of the flight period and sums of daily mean temperatures above a base of 7°C starting March 1. A good correlation was established, however, between the flight period and the growth stages in apple fruit buds. Thus, in all five years less than 10% (from 1 to 8%) of the flight occurred prior to the "¼ inch green stage"; approximately 50% of the catch was taken by the "early tight cluster" stage; and from 95 to 98% by the "mid-pink" stage.

Is there intraspecific competition in *Vespula maculifrons* (Hymenoptera: Vespidae)? W. D. Lord and R. R. Roth, University of Delaware, Newark, DE 19711

A 2-yr study of eastern yellow jackets in 9.4 ha of a Delaware woodlot examined nest location, density, and productivity for evidence of inter-colony competition. Worker populations were indexed by weekly counts from a can-trap grid. Nests were located by a thorough search in August and were excavated in October to determine productivity. The number of nests was 29 in 1976 and 72 in 1977. Workers were much more numerous in 1977. Only 16 of 90 plots of 1000 m^2 each had nests in both years (repeat areas) (16 nests in 1976, 19 in 1977). There were 13 nests in 9 plots used only in

1976 and 53 in 37 plots used only in 1977 (non-repeat areas). Colonies in repeat areas in 1977 tended to be more productive by several criteria (queen and worker comb area, number of queen cells, queen cell size and nest biomass) than ones in non-repeat areas. In 1976 the subhabitats were similar in productivity. These results indicate that density dependent phenomena existed among the wasps. When the nest density in a limited "quality" habitat exceeded a certain threshold, additional nests were accomodated only in "peripheral" habitats. This was especially notable in 1977. The consequence for the excluded queens was an apparent reduction in productivity. Such exclusion may occur due to queen aggression in the spring. Reduced productivity could be due to lower food levels in peripheral areas and/or scramble competition among more workers for food. This mechanism may underlie "wasp cycles."

Diurnal, seasonal and relative abundance of *Myzus persicae* (Sulz.) predators. T. P. Mack and Z. Smilowitz, The Pennsylvania State Univ., University Pk., PA 16802

The diurnal, weekly and seasonal abundance of predaceous natural enemies of *M. persicae*, the green peach aphid (GPA), were determined in potato (*Solanum tuberosum* L. var *Katahdin*) fields in 1977 as a step in the development of a natural enemy sampling procedure. These distributions were determined by visually counting all predators occurring on randomly selected potato stems at 0900, 1115, 1330 and 1545 hours for 7 weeks during the growing season.

Coleomegilla maculata (Degeer) adults (Coleoptera: Coccinellidae) and coccinellid larvae were the most abundant known GPA predators found. *C. maculata* adults were approximately 4 times more abundant than other coccinellids. *C. maculata* adults increased in abundance in a linear manner for the entire experiment. The coccinellid larvae population increased with increasing slope until August 12, and then decreased until the experiment's end. Chi square analysis indicated that the 0900 and 1115 hour sample periods produced the highest means for *C. maculata* adults and coccinellid larvae. No time of day effects on variance of the mean were noticeable. *Chrysopa* larvae (Neuroptera: Chrysopidae), syrphid larvae (Diptera: Syrphidae), and hemerobiid larvae (Neuroptera: Hemerobiidae) occurred in extremely low numbers throughout the season. The most abundant general predators were *Orius insidiosus* (Say) adults and nymphs (Hemiptera: Anthocoridae), *Nabis* spp. adults and nymphs (Hemiptera: Nabidae), and various spiders. Field observations indicated that these arthropods were not primarily feeding on the GPA.

Feeding behavior of mosquitoes (Diptera: Culicidae) on mammals. L. A. Magnarelli, The Conn. Agric. Exp. Stn., New Haven, CT 06504

Precipitin tests have been developed to ascertain host-feeding patterns of mosquitoes. In some studies, mixed blood meals (of different origins) are reported. Incidences of multiple feedings, as determined by precipitin tests, may be conservative estimates because proteins in one of the blood meals may be digested to the point where it is difficult to identify. Accordingly, the feeding behavior of female mosquitoes (representing 8 common *Aedes* species and *Psorophora ferox*) was directly observed on man, anesthetized raccoons, and immobilized white-footed mice in a woodland and salt marsh habitat of southern Connecticut to determine frequencies of intermittent feedings. Results indicate that, when undisturbed, the majority of mosquitoes fully engorged after the initial bite in about 2–3 minutes, but other females sometimes penetrated their fascicles into host skin, exhibited extensive exploratory probing beneath epidermal layers, and withdrew mouthparts 3 times from the same host without ingesting visible amounts of blood. The present study establishes that intermittent feeding occurred in each species, but incidences of such feedings did not exceed 14%. In conclusion, under more natural conditions where hosts react to biting mosquitoes, frequencies of discontinuous feedings are probably much higher than reported here and consequently, repeated biting of different hosts during an ovarian cycle might be epizootiologically significant in the transmission of certain arboviruses.

Seasonal population growth of the southern red mite, *Oligonychus ilicis* (McGregor) (Acarine: Tetranychidae), infesting Japanese holly in New Jersey. D. L. Mague and H. T. Streu, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Populations of *O. ilicis,* an important pest of ornamentals in the Aquifoliaceae and Ericacae, infesting *Ilex crenata* 'Convexa' were assessed in random counts from May 1977 to January 1978 in carbaryl-sprayed and untreated hosts. The treated group showed a five-fold increase in the number of immature mites and a ten-fold increase in the number of adult females and eggs when compared to populations on untreated plants. Initial mite densities in both groups were low (0.002 females/10 leaves) in the spring of 1977 and showed gradual increase over the summer to peak densities (38.7 females/10 carbaryl-treated leaves and 2.5 females/10 untreated leaves) in the fall. Treated populations produced 50.9 diapausing eggs/leaf and caused severe injury to the host foliage. No leaf damage was visible on untreated hosts where only 3.8 overwintering eggs were deposited per leaf. Neither treatment group followed the mite population growth pattern previously

described in the literature as an early summer peak followed by an abrupt mid-summer decline and late season resurgence. Results suggest predation in the unmanaged New Brunswick, NJ plot had maintained mite populations at low densities during previous seasons and was responsible for the variation from population growth trends reported on commercially cultivated ornamentals, where at high initial densities, intraspecific competition on declining food sources during periods of summer plant stress apparently combine to result in an early population crash.

Evolution of Batesian mimicry in the Syrphidae (Diptera). C. T. Maier, Dept. Entomol., The Connecticut Agric. Exp. Stn., New Haven, CT 06504

Many adult syrphids bear a striking resemblance to aculeate Hymenoptera, their suspected models in Batesian mimicry complexes. Although most, if not all, syrphids probably suffer predation from insectivorous birds, only those species which spend most of their life in forested areas are specialized Batesian mimics (those convincing to the human eye). The overwhelming numbers of these mimics are members of the Milesiinae, one of two large syrphid subfamilies. Mimetic flies including *Ceriana abbreviata, Mallota bautias, M. posticata, Sphiximorpha signifera, Spilomyia* spp., and *Temnostoma* spp. have both morphological and behavioral adaptations which enhance their resemblance to their particular model(s). The following probably explain why mimicry evolved principally in species of Milesiinae: (1) They spend proportionally more time than most non-mimetic Syrphinae in forests where potential avian predators are abundant. (2) They have conspicuous foraging and mating behavior which increases the chance of discovery by insectivorous birds. (3) They share many biological attributes such as foraging and larval development sites with their models. These proposals agree with Bates' original postulates. Other factors that probably affect selection for Batesian mimicry include fly abundance, phenology, and size as well as bird behavior. In conclusion, Batesian mimicry is more prevalent in forest-inhabiting syrphid flies because they are apparently more exposed to avian predation than are most non-mimetic species.

Energy metabolism and heat exchange in flying dragonflies (Odonata: Anisoptera). M. L. May, Rutgers Univ. New Brunswick, NJ 08903

Energy metabolism of dragonflies in flight was estimated from data on body temperature in the field, on flight speed, and on variation in heat loss as a function of flight speed. Ranges of metabolic rate in each of seven species varied from $0.98–2.9 \times 10^{-2}$ W in *Miathyria marcella* to $11.2–20.3 \times 10^{-2}$ W in *Macromia taeniolata*. Mean body mass ranged from 0.1–1.2 g,

and energy expenditure increased approximately in proportion to mass. Metabolic rates were comparable to maximum rates in dragonflies during endothermic warm-up. These data were also compared to extensive data from the literature on flight metabolism of other insects. Dragonflies have slightly lower rates of metabolism in flight than most other insects, despite a relatively large mass of flight muscle. The low metabolism correlates with their low wing loading and with the unusual histology of their wing muscles. Data on heat exchange at various wind speeds suggest that heat loss in dragonflies can be roughly described by a simple model of two resistances in series and that the degree of thermal insulation may be adapted to thermoregulatory requirements.

Laboratory feeding studies with selected spiders (Arachnida: Araneae) from Virginia apple orchards. J. P. McCaffrey and R. L. Horsburgh, Shenandoah Valley Res. Sta., VPI & SU, Steeles Tavern, VA 24476

Laboratory feeding studies were conducted to evaluate the potential influence of spider predation on pests and beneficial insects associated with Virginia apple orchards. Individual spiders were confined with one prey insect in a 6 × 2 cm plastic petri dish for 48 h. Each test was replicated 3 times. The adult spiders tested were *Theridion albidum* Banks, *Anyphaena pectorosa* L. Koch, *Philodromus placidus* Banks, *Misumenops oblongus* (Keyserling), *Hentzia palmarum* (Hentz), *Metaphidippus galathea* (Walckenaer), *Phidippus audax* (Hentz) and *Dictyna sublata* (Hentz). The potential prey included alate and apterous forms of *Aphis* sp. and *Dysaphis plantaginea* (Passerini); adults and larvae of *Platynota flavedana* Clemens; adult leafhoppers (Typhlocybinae); adult *Stethorus punctum* (LeConte); adult *Leptothrips mali* (Fitch); and *Chrysopa* spp. larvae. Alate forms of both aphid species were accepted by all spiders, but the apterous forms were accepted only by *T. albidum, M. galathea*, and *D. sublata*. Adults and larvae of *P. flavedana* were accepted by all spiders except *T. albidum* and *A. pectorosa*. Leafhoppers were readily accepted by all spiders. The thrips *L. mali* was fed on by *T. albidum, D. sublata*, and *M. galathea*. Only *T. albidum* and *D. sublata* captured *S. punctum*. No spiders fed on the chrysopid larvae. These results indicate that several pests and beneficial insects could serve as prey for the complex of spiders inhabiting Virginia apple orchards.

Self-regulation in scale insect populations on hemlock. M. S. McClure, Connecticut Agr. Exp. Stn, New Haven, CT 06504.

Population self-regulation in the Homoptera has been linked to the nutrient quality of the host plant and its related effects on the success of feeding nymphs. Studies on the elongate hemlock scale, *Fiorinia externa* Ferris (Homoptera: Diaspididae) have indicated that populations are responsive to changes in the nutrient quality of hemlock related to edaphic conditions of the growing site and to changes in the intensity of feeding following insecticide application. This study investigated the presence of self-regulation in hemlock scale populations by examining the effects of scale density on survival, rate of development, and fecundity. Weekly sampling for two years of ten mature hemlocks in a Connecticut forest revealed that each of these parameters was significantly, negatively correlated with scale density. Scales residing on trees supporting the higher densities suffered up to four times greater mortality, developed more slowly, and produced fewer eggs than did scales on less heavily infested trees. Though initially the densities of feeding nymphs on the ten hemlocks varied considerably (range from 134 to 1011 nymphs per 100 hemlock needles), the densities of scales which subsequently matured were similar (range from 109 to 279). The results indicate that density-dependent self-restraints resulting from a reduction in the quality and availability of essential resources for feeding nymphs maintained populations of *F. externa* at densities below three mature scales per needle. However, hemlocks supporting even these densities suffer significant reductions in growth which may eventuate in tree death. Therefore, it is unlikely that the self-restraints, alone, are sufficient to control hemlock scale.

Modelling for pest management: Analysis of environmental and inherent developmental rate variation on emergence in the alfalfa blotch leafminer (Diptera: Agromyzidae). W. K. Mellors and R. G. Helgesen, Cornell Univ., Ithaca, NY 14853

The objective was to account for the variation observed in the cumulative adult emergence patterns of field populations of the alfalfa blotch leafminer, *Agromyza frontella* (Rondani). Observed emergence patterns were compared to computer simulated patterns based on (1) variation in developmental rate alone, (2) variation in environmental temperature alone, and (3) the combination of the two. Variation in developmental rate was quantified through controlled laboratory rearings of pupae at constant temperatures. The 10, 30, 50, 70 and 90th percentile developmental rates were determined for the distribution of rates observed at each temperature. Temperature

variation in the soil environment of pupae within a site was analyzed with respect to (1) variation in space and (2) variation with depth. Soil temperatures were recorded in the field throughout pupal development periods. Pupal development to adult emergence was simulated using the temperature records and the temperature-dependent developmental rates. The extent to which a simulated pattern accounted for the observed pattern was computed as the r-squared value between the observed and simulated dates with the same percent cumulative emergence. The simulations based on both temperature and developmental rate variation, on rate variation alone, and on temperature variation alone, respectively, accounted for 94, 90, and 88% of the variation in the emergence patterns observed in the spring of 1978. The two sources of variation accounted similarly for the observed variation under these specific field conditions.

Thermal requirements for development of the parasite *Microctonus aethiopoides* Loan (Hymenoptera: Braconidae). J. Morales and A. A. Hower, Pennsylvania State Univ., Univ. Pk., PA 16802

Laboratory studies indicated that the threshold temperature for development of *Microctonus aethiopoides* larval and pupal stages is 8.4°C (47°F). The regression equations for the developmental time of various life stages of the parasite were computed from the logarithm of the average duration of the stage in days and the log temperature in °C. The regression equations for the rate of development were derived from the daily percent of development in relation to temperature. This relationship was linear within the range of temperatures supporting complete development ($r^2 = 0.97$). Temperatures were converted to a cumulative degree-day summation. Degree-days were computed using the mean duration in days for complete development of various life stages of the parasite above 47°F. Averages of 228 and 240 degree-days were required for development of the larval and pupal stages, respectively. Total parasite development, from first instar larva until emergence of the adult parasite, required an average of 469 degree-days.

During two years of field studies 50% of the first and second parasite generations emerged when means of 463 and 947 degree-days, respectively, had accumulated after January first. These data validate the use of degree-days to forecast *M. aethiopoides* emergence in the field. Based on this information insecticide application could be timed to avoid the parasite and thus increase its potential against the alfalfa weevil.

Separation and quantitation of dytiscid defensive secretions using high-pressure liquid chromatography. A. T. Newhart and R. O. Mumma, Pesticide Research Lab. and Dept. of Entomol., The Pennsylvania State Univ., Univ. Pk., PA 16802

High-pressure liquid chromatography methods were developed for the analysis and purification of dytiscid defensive secretions. These methods were rapid, sensitive, quantitative and allowed the simultaneous analysis of pygidial and prothoracic gland contents. Separations were achieved with a normal phase column (μPorasil) using a dioxane:hexane solvent system and with a reverse phase column (μBondapak) using an acetonitrile:water solvent system. Four species of dytiscids were analyzed using these methods: *Acilius semisulcatus*, *A. sylvanus*, *A. mediatus* and *Graphoderus liberus* Say (Coleoptera: Dytiscidae). The pygidial glands of all four species were found to contain the antimicrobial agents: benzoic acid, *p*-hydroxymethyl benzoate and *p*-hydroxybenzaldehyde. The prothoracic gland of all three *Acilius* species produced the same compounds, one of which has been identified as an 4-androsten-3-one steroid. Deoxycorticosterone was the major steroid produced by *Graphoderus*, confirming earlier studies. The seasonal defensive titer of the pygidial and prothoracic gland contents of *A. semisulcatus* was studied over a five month period and were found to vary independently. The pygidial antimicrobial agents reached their maximum titer in July while the prothoracic gland steroid quantified remained at low levels throughout the summer months, rapidly reaching a maximum titer in October.

Orientation disruption of *Argyrotaenia velutinana* and *Choristoneura rosaceana* (Lepidoptera: Tortricidae) male moths. M. A. Novak, W. H. Reissig and W. L. Roelofs, Dept. of Entomol. NY State Agric. Exp. Stn., Geneva, NY 14456

Most species of the complex of tortricid leafroller moths which are pests or potential pests in New York State apple orchards use blends of (*Z*)-11-tetradecenyl acetate (Z11-14:Ac) and E11-14:Ac as major pheromone components. Various mixtures, release rates, and methods of application of these have been previously tested for their effectiveness as mating disruptants. We now report tests with pheromone components and pheromone analogs, dispensed from hollow capillary fibers, for effectiveness in disrupting orientation to pheromone-baited traps in small field plots. The species selected for the tests were *Argyrotaenia velutinana* (Walker), the redbanded leafroller, and *Choristoneura rosaceana* (Harris), the oblique-banded leafroller. *A. velutinana* was effectively disrupted by Z11-14:Ac alone or combined with other chemicals, at a release rate as low as 3 mg/h/ha. *C. rosaceana* required a mixture containing both Z11-14:Ac and (*Z*)-11-

tetradecen-1-01(Z11-14:OH), a minor pheromone component. A 1:1 mixture of these compounds, each at a release rate of 5 mg/h/ha, and a mixture of the Z and E 11-14:Ac's and the Z and E 11-14:OH's at 5 mg/h/ha each, were both effective disruptant systems. Neither Z11-14:OH nor (Z)-11-tetradecenyl formate (Z11-14:formate), which decrease trap catches for *A. velutinana*, were effective alone for disrupting either species. (Z)-11-tridecenyl acetate (Z11-13:Ac), an attractant for *A. velutinana*, effectively disrupted this species, but not *C. rosaceana*. These tests show that differences exist in the systems necessary for disrupting these two leafrollers, although their natural pheromone blends are very similar.

Field evaluation of pheromone baited trap-trees to control elm bark beetles. D. P. O'Callaghan, E. M. Gallagher and G. N. Lanier, SUNY College of Env. Sci. and Forestry, Syracuse, NY 13210

Subsequent to the isolation, identification and synthesis of the aggregation pheromone of *Scolytus multistriatus* (Marsham)—principal vector of Dutch elm disease (DED)—and its use in mass trapping there has been a decline in new cases of DED from 1975 through 1977 in most areas where pheromone traps have been employed.

The concept of baiting diseased trees with pheromone ("Multilure") and killing them with the herbicide cacodylic acid—applied either to axe frills or by pressure injection—is presently being evaluated as a management technique. Elms, thus poisoned, are heavily attacked by the beetles but their broods fail to develop. In three areas—two close to Syracuse, NY and one in Wisconsin, four and five square miles in area respectively—large numbers of diseased elms have been killed and baited. A grid of Multilure baited traps, at ¼ mile intervals on utility poles, serves to monitor beetle populations in these and the concomitant check areas. Results to date indicate that large numbers of beetles are absorbed by trap trees and their brood destroyed. Although this study is less than half way advanced, the indications are that the pheromone baited trap tree approach has a devastating effect on beetle populations and should effectively reduce DED rates.

Laboratory rearing of *Leptothrips mali* (Fitch) (Thysanoptera: Phlaeothripidae). M. P. Parrella and R. L. Horsburgh, Shenandoah Valley Res. Sta., VPI & SU, Steeles Tavern, VA 24476

Leptothrips mali (Fitch) has been found associated with high densities of mites in Virginia apple orchards. Laboratory rearing methods were needed before an adequate assessment of this thrips' biology and mite control potential could be made. Field collected adults were housed in pint cartons

containing apple leaves. The containers were modified by cutting a hole in the bottom allowing the petioles to extend into water and by replacing the top with a fine muslin cloth. Eggs were removed from the leaves with a wetted minuten probe and placed on moistened filter paper in plastic containers (4.1 cm diam × 1.3 cm deep) with friction-sealed lids. Prior to eclosion, an egg was transferred to the underside of an apple leaf resting on saturated cotton. The egg was placed in an arena (ca. 10 cm^2) bordered with Stickem®which contained European red mite eggs (*Panonychus ulmi* (Koch)). The center of the arena was covered with a portion of leaf tissue. Two days post-eclosion, the larva was transferred to another leaf arena made by inverting the bottom of a plastic petri dish with its top replaced by 100 mesh screen over the underside of an apple leaf. The container and leaf fitted on one-half of a larger petri dish, and the whole apparatus was held firmly in place by a rubber band. The supporting dish rested in saturated cotton. The thrips completed development in this leaf container. Rearing conditions were 23.9° ± 1°C, 14-h photoperiod, and 80–100% RH.

Life history and population dynamics of *Heteroplectron americanum* (Walker) (Trichoptera: Calamoceratidae). J. W. Patterson and R. L. Vannote, Dept. of Entomol. and Applied Ecol., Univ. Delaware, Newark, DE 19711

Monthly samples of *Heteroplectron americanum* were taken from the headwaters of Blackbird Creek on Delaware's coastal plain. Adults emerged from mid-May to early June. Females contained an average of 387 eggs which were deposited within a gelatinous matrix either under water on branches and logs or attached to tree roots and mosses on the stream bank. Larvae began to hatch in about 15 days and remained within the gelatinous matrix for a time period varying with the frequency of inundation. Egg masses deposited above the wetted zone of the stream bank desiccated within two days. First instar larvae weighed 0.01 mg, constructed a case of detrital fragments, and fed on leaf fragments and wood. During the second or third instar, larvae began to hollow out twigs for cases. Most individuals attained the final instar (5th) by December ($\bar{x}$ = 8.7 mg). Growth then ceased until mid-March when the average stream temperature reached 6°C. Larval growth was completed by May when the mean dry weight of mature male and female larvae was 6.5 mg and 16.1 mg, respectively. The pupation period was approximately 21 days. A small proportion of the population (<25% >2%) did not achieve sufficient growth to complete development in one year. A one year generation time was confirmed by following the growth of larvae developing from 40 egg masses introduced into a Piedmont spring brook where this species was not previously present.

Indirect effects of gypsy moth *Lymantria dispar* L. (Lepidoptera: Lymantriidae) insecticides, on the parasite *Apanteles melanoscelus* (Ratzeburg) (Hymenoptera: Braconidae). E. H. Pollack and A. J. Forgash, Rutgers Univ., New Brunswick, NJ 08903

Apanteles melanoscelus, an important monophagous parasite of early-instar gypsy moth, is actively searching for hosts around the time of chemical applications for control of the pest. Current knowledge of the effect of insecticides on *Apanteles* consists primarily of qualitative information on direct toxicity of a few insecticides. To aid in filling this void we have devised testing procedures for detecting potential impacts of insecticide-containing hosts on parasite activity, behavior and reproductive success. We have applied these methods to the study of effects of carbaryl, acephate and trichlorfon on *A. melanoscelus*.

Second-instar gypsy moth larvae that survived topical or oral doses of carbaryl, ranging from LD 20 to 85, were parasitized and the progeny were compared to those from untreated hosts with respect to (1) numbers of larvae emerging, (2) number of viable adults, (3) sex ratio and (4) length of time for parasite development. Tests were also conducted to detect (1) parasite discrimination between treated and untreated hosts and (2) chronic effects arising from continuous rearing in treated larvae.

The results show conclusively that *Apanteles* (1) develop normally in carbaryl-treated gypsy moth, (2) are not affected by rearing in treated larvae for 4 successive generations and (3) do not discriminate between treated and untreated hosts. Similar studies, in progress, indicate that larvae which survive topical treatments of acephate or trichlorfon are also compatible hosts for *Apanteles*.

Morphology and taxonomy of first-stage nymphs of five *Periplaneta* Burmeister (Dictyoptera: Blattidae). P. K. Powell and W. H. Robinson, Virginia Polytechnix Inst. and State Univ., Blacksburg, VA 24061

First-stage nymphs in the genus *Periplaneta* have not previously been well described. First-stage nymphs of four Nearctic and one Palearctic species (*P. japonica*) can be separated on the basis of pattern and number of setae on the dorsum of the thorax, particularly the mesonotum. In *P. australasiae* the mesonotum is very setose, it is less setose in *P. fuliginosa* and *P. brunnea*, and in *P. americana* and *P. japonica* it is almost totally bare. Color pattern is also a useful character for separating all but two of the five species. Nymphs of *P. americana* and *P. japonica* are solid in color. *P. americana* nymphs are characteristically light grayish-tan, while *P. japonica* nymphs are dark brown, almost black. Nymphs of *P. australasiae*, *P. brunnea*, and *P. fuliginosa* are patterned on the mesonotum,

second abdominal segment, and some antennal segments with light bands and patches. *P. brunnea* can be separated from the other two patterned species by abdominal color, which is much lighter than the head or thorax in *P. brunnea* and concolorous with the head and thorax in *P. australasiae* and *P. fuliginosa*. These two species cannot be separated by color pattern; one must rely on setal pattern and number.

Complementary foraging of bee species in blueberries. E. G. Rajotte and R. B. Roberts, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Populations of bees were sampled in a field containing 3 cultivars of blueberries (*Vaccinum corymbosum*) in an area of southern New Jersey where both native bees and honeybees are abundant. The flowers of cultivars Earliblue and Coville are known to be unattractive to honeybees while Weymouth is highly attractive.

Ten bushes in each of three positions (edge of field, 21*st* bush in, 41*st* bush in) within each cultivar were sampled using a modified automobile vacuum cleaner on each of 15 days from April 18 to May 12, 1976. Collected bees were counted and grouped in three categories (honeybees, bumblebees, other wild bees).

Analysis of variance revealed a significant position effect indicating that the pollinators, especially honeybees, preferred the bushes to the interior of the field that were not buffetted by the wind. There was no significant cultivar effect (i.e., bees were spread evenly among the cultivars) but there was a significant cultivar X bee group effect indicating that certain groups of bees preferred certain cultivars. Although each group of bees differed in their cultivar preferences, their foraging patterns were complementary. Thus, the number of pollinator visits were similar and all three cultivars produced good fruit yields. When bumblebees and other native bees are scarce, complementary foraging does not occur and blueberry cultivars shunned by honeybees produce little fruit.

Effect of juvenile hormone on mating behavior of female German cockroach, *Blattella germanica* (L.) (Dictyoptera: Blattellidae), S. B. Ramaswamy and A. P. Gupta, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Studies of the effects of JH on insect behavior are few. This report deals with the effects of JH on mating behavior of female *B. germanica*. JH treatment of last instar nymphs produces black females owing to excessive melanization (Das, Y. T., and A. P. Gupta, 1977, Nature, 268:139–40).

These females elicit a typical pheromone-induced wing raising behavior in normal males but do not mate. Bioassay of methylene chloride-extracts of black females placed on filter papers also shows the wing raising behavior in males. This shows that these treated females are capable of pheromone production. However, based on the bioassays, it appears that there is a delay in pheromone production of about 48 hr in treated females compared with normal ones. Comparison of electroantennograms of treated and untreated females responding to various attractants shows a decrease in the response of treated females.

Preliminary examination of antennae of treated females shows the sensilla to be highly melanized, as the rest of the body, including the sensillar pits which appear black. Therefore, it is likely that the perception of the male pheromone by treated females is either entirely lacking or substantially reduced following JH application owing to the melanized antennal sensilla. This might explain the behavioral anomaly in treated females and the absence of mating.

Aerial application for the control of alfalfa weevil larvae (*Hypera postica*) in Virginia, 1978. J. E. Roberts and M. T. Snider, Ext. Entomol., VPI & SU, Blacksburg, VA 24061

Treatments were applied on May 11, 1978 to large nonreplicated plots. The airplane used was a Gruman Ag. Cat. G164A equipped with 4664 jet nozzles spraying a swath width of 45 to 50′ at a speed of approximately 100 mph. Spray concentrates were applied in 2, 3, or 5 gal. of H_2O/acre at 22 psi. Weevil larvae data were recorded 2 days prior to treatment and post-treatment at 7 and 14 day intervals. Weevil population data were recorded from 10 stems plucked from each plot. Total population counts were made on the first two of ten stems found containing larvae. The remaining tips were counted as either being infested or not infested and totals were combined and recorded under % Infestation.

Sumithion 8E, Imidan in 5 gal. H_2O/A and Supracide were the only treatments to give better than 80% control during the test. Sevin UCSF-1 and Imidan in two gallons H_2O/A were the only treatments that gave consistent or increasing rates of control.

True armyworm (*Pseudaletia unipuncta*) control in Virginia, 1978. J. E. Roberts and M. T. Snider, VPI & SU, Entomology, Blacksburg, VA 24061

Five insecticides were tested for the control of true armyworms in Montgomery County, Virginia during 1978. Plots were 14′ by 50′ (4 rows) replicated four times in a randomized complete block design. The two center rows were used for evaluating treatments. A compressed air sprayer oper-

ating at 30 lbs. psi duster was used for the sprayable materials. A hand cranked seeder was used to apply the granular materials in a 7 inch band. Insect population counts were taken on June 14 immediately before treatment. This pretreatment population count was taken randomly of 50 plants over the entire test area to show established infestations. Posttreatment evaluations were made on June 16, and June 19, by counting the insect populations on 50 plants per plot. The percent control was based on the untreated checks. The sprayable materials had the best percent control with PenncapE having the best overall ratings.

Field evaluation of post emergence control of cutworm (*Agrotis ipsilon*) in Virginia, 1978. J. E. Roberts and M. T. Snider, VPI & SU, Ext. Entomol., Blacksburg, VA 24061

Four insecticides were evaluated for cutworm control in Halifax County, Virginia during 1978. Plots were 14′ by 50′ (4 rows) replicated four times in a randomized complete block design. The two center rows were used for evaluating treatments. The evaluation was made by counting the total number of live plants per treatment. A compressed air sprayer operating at 30 lbs. psi spraying 36 gal. per acre was used to apply the test materials. Treatments were applied broadcast as a foliar application on June 6, postplant. Plant population counts were taken pretreatment on June 6, and posttreatment plant population counts were made on June 8. Posttreatment population counts were apparently influenced by a prolonged germination period in certain areas which caused data to show a lesser amount of cutworm damage than was actually present.

Phytotoxicity averaged from .25 to 3.25 on a scale of 0–5 where 0 = no damage and 5 = dead plants. Lorsban 4E had the lowest phytotoxicity average of the four insecticides with .25.

Variability in nectar production by an American linden. R. B. Roberts and E. G. Rajotte, Dept. Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Tilia americana, known as basswood or American linden, is renowned as a source of honey. In 1977, a single tree 1 meter in diameter was studied in order to learn how much nectar sugar may be produced and how it is perceived and utilized by bees. The tree produced approximately 3.3 million flowers in 1977, but only a few thousand in 1978. Thus, year to year variability is significant. In 1977, 800 flowers were tagged upon opening and their age was recorded when they were harvested. Half were open to pollinators and half were enclosed in netting to exclude pollinators. Sugar con-

tent of the flowers was analyzed spectrophotometrically. Analysis revealed that the flowers secreted sugar rapidly for the first two days after opening. If not removed, the sugar content remained more or less constant until the 5th day. Sugar content dropped on the 6th day and the flowers usually dropped at the end of the sixth day. The tree bloomed for a period of two weeks. Enclosed flowers yielded an average of 6.0 mg of sugar and open flowers yielded 0.6 mg. Thus, pollinators removed 17.8 kg of sugar from the tree, enough to make 21.6 kg of honey. If nectar is replaced by the flower as a result of its removal, the productivity of the tree would be even higher than measured. Enclosed flowers of the same age harvested on the same date typically showed a 10-fold range in sugar content. Thus, although trends were noted, nectar production varied significantly.

Aspects of the nesting behavior of *Cerceris watlingensis* in relation to its geographical location (Hymenoptera: Sphecidae). P. Salbert and N. Elliott, Dept. of Biol. Hartwick College, Oneonta, NY 13820

C. watlingensis has so far been collected only from San Salvador Island, the Bahamas. Studies of its nesting behavior, conducted during November and December, 1977, indicate differences from previously studied species of *Cerceris*, most of which are northern and continental in distribution. Many of these differences are clearly related to the subtropical and insular location of the species.

As compared with northern species, *C. watlingensis* has a longer season of activity. Females of this species constructed more extensive nests with deeper main burrows and greater numbers of cells. Nests contained cells of a variety of ages, from those with newly laid eggs to old cells from which adults had already emerged. Thus there is an overlap of adult generations, which is one prerequisite for social behavior. There is evidence that nest sharing occurs in *C. watlingensis*.

The remote location of the island contributes to a low diversity of the insects normally associated with sphecid wasps. Females of this species preyed only on curculionids. Of the 62 whole-prey records for *C. watlingensis*, ninety percent belonged to a single species of weevil in the genus *Artipus*. This is the most common weevil on the island; probably few other species of suitable size are present. Many of the parasites and predators that usually attack digger wasps are absent on San Salvador, but ants have been observed to prey on adults and attack the nests.

The sexual behavior of *Tenodera sinensis* (Saus.) (Orthoptera: Mantidae). M. E. Schauff and J. C. Jones, Dept. Entomol., Univ. Maryland College Park, MD 20742

The sexual behavior of praying mantids is not well known. Upon sighting a female, males of *T. sinensis* immediately "freeze" in position. The duration of the interval between sighting and pursuing of the female varied from 2 minutes to 4 hours. Males always flew to the females. As he flies, the male turns in mid-air, approximately 180° and lands on the female's back, facing her rear. He must re-orient to her front end before he will initiate copulation. After re-orientation, the male begins probing with his genitalia about the posterior end of the female's abdomen, while he lightly strokes the female's head and antennae with rapid alternating strokes of his own antennae. The female either reacts by raising her abdomen, preventing coitus, or she may keep her abdomen level, allowing the male to copulate. Duration of copulation averaged 2 hours 59 minutes. After coitus, most males quickly fell off of or directly flew away from the female. Some males were observed to remain on the female as long as 3 hours 25 minutes following copulation. Courting males were captured and eaten only twice in twenty encounters. Although the genitalia of these males began copulatory movements, they did not copulate. On three occasions, precopulatory abdominal searching movements were elicited without contacting the female.

The adaptive significance of the latitudinal cline in oviposition site of *Alsophila pometaria* (Lepidoptera: Geometridae). J. C. Schneider, Dept. Biol., Princeton Univ., Princeton, NJ 08540

Oviposition by the fall cankerworm is usually on twigs in low latitudes (e.g. NC) and on trunks in high latitudes (e.g. NY). In NJ, where oviposition occurs in both places, I have shown that, as for the winter moth *Operophtera brumata*, the degree of synchrony between hatch and foliation greatly affects the fitness of the insect. The variance in time of hatch of egg masses on trunks is higher than that for ones on twigs due to aspect effects. A female ovipositing on a trunk increases the variance in time of hatch of her eggs by ovipositing at two sites. If leaf flush is less predictable at higher latitudes, oviposition on trunks is seen to be a maximization of minimum fitness strategy (a hedge against 100% mortality). Hatch tracks variation in foliation time among stands of different composition. Clones in a gynogenetic system specialize on different hosts and have different developmental requirements. In NJ part of the tracking is accomplished by differences in oviposition time. Diapause development is finished after weather warms above the threshold for embryo development. In New Brunswick, Canada

winters are too cold for this. Thus somewhere north of NJ the tuning of time of hatch by oviposition time is lost so leaf flush may be more unpredictable.

Dietary preferences and patterns of occurrence of Lepidoptera larvae in a northern hardwoods forest. J. C. Schultz, P. J. Nothnagle and R. T. Holmes, Dept. Biol. Sci., Dartmouth College, Hanover, NH 03755

Lepidoptera larvae at endemic population densities were sampled from four tree species at three levels in the Hubbard Brook Experimental Forest in New Hampshire. 400-leaf samples were visually inspected from over 600 trees during 1977 and 1978. There were no significant differences in density of total larvae among the tree species or among layers over the summer growing season. However, there were significantly more geometrid larvae than expected on maples, and fewer on beech and birch. Noctuid larvae occurred on beech and birch more often than expected. Tortricids were more abundant than expected on beech; gracilariids preferred sugar maples.

Choice tests and growth experiments with both field-collected larvae and those reared from eggs revealed some strong dietary preferences. Some species exhibited little or no host discrimination.

These results, in addition to patterns of occurrence of over 50 larval taxa, indicate that feeding preferences of forest Lepidoptera range from very broad to very narrow within a single community. Our community-wide survey leads us to conclude that the suggestion that forest Lepidoptera should have broad diets because their hosts are chemically convergent may be naive. Factors such as within-tree variation in tissue quality and differential use of trees in predator avoidance may favor specialized diets among forest insects.

Biological and physical influences on the mass rearing of *Coccygomimus turionellae* (Hymenoptera: Ichneumonidae). P. B. Schultz, Virginia Truck and Ornament. Res. Stn., Virginia Beach, VA 23455 and L. T. Kok, VPI and SU, Blacksburg, VA 24061

Biological and physical factors affecting the rearing of *Coccygomimus turionellae* (L.) on wax pupae were examined to determine the optimum conditions for its mass propagation. The most critical factors were the parasite:host (P/H) ratio, and duration of exposure of host to the parasite. In a study involving seven P/H ratios and three exposure times, optimum parasite emergence occurred with a ratio of 0.4 or 0.5 at 24-h exposure, and with a ratio of 0.1 at 72-h exposure. Production of *C. turionellae* could be increased by retarding pupal development of the wax moth. Decreasing the

storage temperature of wax moth pupae from 32° to 27°C extended the duration of its suitability for parasitism from two to seven days. Prompt removal of wax moth pupae from the 32°C rearing temperature was found to increase the emergence of *C. turionellae*. Mass rearing was unaffected by the age of *C. turionellae*. The optimum temperature for propagation of *C. turionellae* was 27°C but oviposition activity was high at 21 and 32°C. A 12-h photoperiod and 600–6000 lux light intensity were optimum for production. A significant drop in fecundity did occur after 14 generations of laboratory rearing. This 21% reduction in parasite progeny emergence between 1976 and 1977 could be attributed to inbreeding within the colony.

Occurrence of beneficial insects on flue-cured tobacco treated with soil insecticides. P. J. Semtner and J. E. Roberts, Sr., S. Pied. Cntr. and Dept. Entomol., VPI & SU, Blackstone, VA 23824

There has been a steady increase in the use of soil insectide-nematicides in tobacco production in Virginia during the last ten years. For this reason, an investigation was initiated to evaluate effects of soil insectides on several beneficial insects that occur on tobacco. The stilt bug, *Jalysus spinosus* Say, which feeds on eggs of the tobacco hornworm, *Manduca sexta* (L.), and *Nabis* spp., which feed on many tobacco insect pests, were the most abundant beneficial insects in this investigation. Fifteen insecticides and insecticide formulations, including ethoprop, ethrop-disulfoton, fensulfothion, disulfoton, disulfoton aldicarb, Standak, Nematak, carbofuran, Vydate, and a carbofuran-disulfoton combination were evaluated for their effects on beneficial insects and their prey. Stilt bug populations were greatly reduced on tobacco treated with Standak, aldicarb, Nematak, disulfoton, and the carbofuran-disulfoton combination. Tobacco hornworm populations were highest in the Standak and aldicarb treatments, indicating that the reduced number of stilt bugs may have caused increased hornworm populations. This was not the case through all the treatments. Carbofuran had little effect on the stilt bug, other than reducing its food supply. Although low tobacco hornworm populations occurred in the carbofuran treated tobacco, stilt bug populations were only slightly lower than the untreated check. Tobacco receiving ethoprop and disulfoton 6LC had higher stilt bug populations than the check. *Nabis* spp. were least abundant on tobacco treated with Standak, Vydate, and aldicarb.

Influence of diet upon gypsy moth NPV production. M. Shapiro, R. A. Bell and C. D. Owens. USDA, SEA. Otis AFB, MA 02542

The influence of diet upon gypsy moth NPV production was examined. Major dietary ingredients as wheat germ, casein, vitamins, sucrose, and salts were evaluated. In addition, influence of diet pH and the use of agar substitutes were studied.

Several published diets were compared to the Otis production diets. The modified hornworm and Otis high wheat germ diets were superior to the Leonard-Doane, Odell-Rollinson, Magnoler, Ridet, and Shorey-Hale diets. Although virus yield was greatest using the modified hornworm diet, virus production was least expensive using the high wheat germ diet.

Several wheat germ products were examined, and the raw wheat germ was slightly better than the toasted material. Several protein sources were compared to casein (the standard) and were found to be comparable. An increase in vitamin mix concentration resulted in little increase in virus yield. Several sugars were compared to sucrose (the standard) and were comparable in activity. Wesson salts (standard) were compared with salt mixes used in tissue culture, and the standard was superior.

Little differences in virus yield occurred at diet pHs between 4–7. As the pH increased to 8, virus yield decreased. Several carrageenans were compared to agar at concentrations ranging from 0.75 to 2 percent. The most commonly used carrageenan, Gelcarin HWG, was comparable to agar.

Interfacing green peach aphid, *Myzus persicae* (Sulz.) damage with season potato plant growth. Z. Smilowitz, M. E. Whalon, C. A. Martinka and E. S. Nolan, The Pennsylvania State University, Univ. Pk., PA 16802

Potato plant growth characteristics were interfaced with green peach aphid, *Myzus persicae* (Sulz.) (GPA) population levels to develop seasonal damage indexes. Potato plots treated with five rates of systemic insecticide, aldicarb, at planting were sampled weekly for GPA following establishment of winged migrants. Temperature dependent models using accumulated day degrees were established for foliage and tuber yields from plant growth production data collected on alternate weeks. The relationship of pest numbers and foliage production was determined from accumulated foliage production at each of the harvest periods. The percent foliage loss was determined from the proportion of foliage harvested and the maximum foliage obtained at each phase of plant growth. The percent foliage loss and GPA numbers were regressed to establish foliage loss/GPA for each sample period. These values were compared with accumulative foliage day degrees to establish the realtionship of plant growth and GPA damage throughout the season.

Peak foliage production occurred at approximately 1300 accumulated foliar day degrees. Following this phase of plant growth production remained at a high level at low pest densities, whereas high density caused a decline. GPA had the greatest impact on foliage production early in the season; 1300 accumulated day degrees. Pest impact declined logarithmically as the season progressed.

The effect of larval host exposure on the oviposition preferences of *Pieris rapae*. J. H. Smith and W. G. Yendol, The Pennsylvania Sta. Univ., University Park, PA 16802

Two experiments were conducted to test the effect of larval host exposure on the oviposition preferences of *Pieris rapae* (L.) (Lepidoptera: Pieridae). In one experiment, groups of *P. rapae* were raised on either 'Savoy King' (*Brassica oleracea* var. *sabauda*) or 'Premium Late Flat Dutch' (*Brassica oleracea* var. *capitata*) cabbages, and as adults their oviposition preferences for these two cultivars were tested. In a second experiment, the oviposition preferences of field-collected gravid females were determined for the same two cultivars.

Preference test procedures were similar for both experiments. Mated females with the same larval host background were released in groups of 5 into outdoor screen cages containing 10 'Savoy King' and 10 'Premium Late Flat Dutch' plants. After 6¼ hours, the females were removed and the number of eggs laid on each plant was determined.

Laboratory-reared females laid the same number of eggs on both cabbage cultivars, regardless of which host cultivar they were reared on. In contrast, field-collected females laid significantly more eggs on 'Savoy King' than on 'Premium Late Flat Dutch' cabbages.

The oviposition preferences of laboratory-reared *P. rapae* were not mediated by pre-imaginal conditioning. In addition, host preferences of the laboratory-reared females did not represent preferences of females from the field population. It seems possible that the development of *P. rapae* oviposition preferences is influenced by adult host experience.

Effect of low temperature on survival of red pine scale *Matsucoccus resinosae* Bean and Godwin (Homoptera: Margarodidae). G. R. Stephens, Connecticut Agr. Exp. St., P. O. Box 1106, New Haven, CT 06504

During 1976–78 the effect of low temperature on survival of red pine scale overwintering on 4- to 6-year-old potted red pine was studied. During January and February pines were taken from outdoor storage and subjected to 1, 2 or 5, 4-hour exposures at −23 C or continuous exposure for 1 to 80

hours at −15 to −27 C in a large freezer. Therafter treated trees and controls were maintained above freezing. Mortality was determined 7 to 10 weeks after treatment when surviving nymphs entered the next growth stage. Scale mortality was greatest on 1-year-old branches and decreased as branch age increased. Mortality was generally least on 3-year-old branches where scale populations are often highest. In 1976 scale mortality was 31% on 3-year-old twigs after 5 4-hour exposures at −23 C compared to 27% on controls. In 1977 continuous exposure of 1 to 80 hours at −15 to −27 C revealed that most mortality occurs during the first few hours of exposure and increases slowly thereafter. In 1978 two populations were compared at continuous exposure of 1 to 75 hours at −18 to −27 C. After 25 hours at −27 C there was 97.6% mortality from a source near Long Island Sound compared to 93% for a source near the northern limit of infestation in Connecticut. The lack of complete mortality at prolonged temperature indicates that this scale is capable of infesting red pine throughout southern New England and southern New York and the reduction in mortality compared to a 1957 report suggests that a more cold-hardy scale has developed during the last 20 years.

White grub control in turf with Bendiocarb (NC 6897). W. W. Surles and W. L. Ekins, Fisons Corp., 2 Preston Court, Bedford, MA 01730

Bendiocarb (NC 6897) is a carbamate insecticide, which exhibits good soil activity and moderate mammalian toxicity. Data generated by unviersity researchers have demonstrated excellent activity against turf-feeding white grubs (numerous species) at 2.0 to 4.0 lb ai/A and varying activities against other turf infesting arthropods. Working under Experimental Use Permit programs approved by the Environmental Protection Agency, Fisons' personnel field-tested three formulations (76 WP, 2.5 G and 5 G) in 1977 and 1978. Non-replicated, practical application trials were conducted in the Central and Northeastern United States on home lawns. Pre and post-treatment population assessments were monitored for: 1) untreated; 2) bendiocarb and 3) plots treated with a standard product. Data were taken and observations were conducted to evaluate: efficacy (for early spring and late summer applications), turf and applicator safety, irrigation effect and ease of application. The results indicated that bendiocarb provided at least 80% control of the white grub complex at 2.0 lb ai/A in most areas; however, 4.0 lb ai/A were required in New York and Central Texas. Late summer and early spring trials demonstrated good activity against all larval stages. Post-treatment irrigation was required to ensure this high level of activity. These findings complement the results obtained from researcher trials and confirm the desirability of eventual registration of bendiocarb.

Biology and control of the Northern fowl mite on caged layers. E. C. Turner, Jr., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061

Historically, laying hens have been infested by the common chicken mite, *Dermanyssus gallinae* (De Geer) and the Northern fowl mite, *Ornithonyssus sylviarum* (Canestrini & Fanzago). However, most commercial egg producers now house their hens in cages. This management practice has virtually eliminated the chicken mite as a pest but has greatly encouraged the development of large populations of Northern fowl mites on the caged birds resulting in reports of losses in egg production and complaints by personnel operating the houses and egg packing rooms. Dissemination of mites in large caged layer houses has been observed to be primarily from egg trays, conveyer equipment, and even the eggs. In some cases, wild birds, escaped hens and rats can play a part in this dissemination.

Recent research has indicated that stress, through the release of corticosterones, is an important factor in the ability of the host to support or resist populations of Northern fowl mites. Cages housing two or more birds will result in reduced mite populations while birds housed alone will support large mite populations. The mechanism of host resistance to mites was found to be due to decreased capillary density in the skin proximate to the vent of the bird.

Synthetic pyrethroid insecticides permethrin and SD 43775 applied as sprays at dosages of 0.125 and 0.0125% AI respectively has resulted in excellent long term control of the mite.

Recognition of virus-diseased gypsy moth larvae by *Apanteles melanoscelus* Ratzeburg (Hymenoptera: Braconidae). P. L. Versoi and W. G. Yendol, Pesticide Res. Lab., Penn State Univ., Univ. Park, PA 16802

The objective was to determine if the parasite, *Apanteles melanoscelus* could discriminate between diseased and healthy gypsy moth (GM) larvae. The disease agent used was the Gypsy Moth Nuclear Polyhedrosis Virus (GMNPV). The incidence and frequency of behaviors including parasite-host contacts, and subsequent ovipositor probing were used for indicating host preferences. The basic procedure involved transfer of 5 mated, female parasites with no prior host encounters into a test chamber containing 10 mid-3rd instar (55–80 mg) GM larvae. During confinement of the parasites with host larvae, behavioral activities of the parasites were video-recorded for 30 min. This approach was repeated a number of times for each of the following 4 preparations: healthy GM with movement unrestricted; healthy GM with movement restricted; diseased GM with movement restricted; and 5 diseased larval GM and 5 healthy larval GM in the same container with movement restricted. The results of this investigation indicated: (1) *A. mel-*

anoscelus females were able to distinguish between healthy and diseased hosts, as evidenced by behavioral discrimination, and (2) a greater percentage of the healthy GM larvae were attacked by the parasites when compared to moribund, GMNPV-infected larvae. Such information would be important in assessing the efficacy of these two biological agents when being considered as components of GM management systems.

The relationship of the maple cambium miner, *Phytobia setosa* (Loew) (Diptera: Agromyzidae) to its host. W. E. Wallner and R. A. Gregory, U. S. Forest Service, Hamden, CT 06514

The maple cambium miner, *P. setosa*, attacks *Acer* spp. producing ray flecks which result in degrade in face veneer and furniture wood. The purpose of this study was to determine the histological relationship of *P. setosa* to sugar maple and determine if mines influenced sap sugar content. It was found that while mines pass close to the vascular cambium the initial cells were unaffected hence even though called a cambium miner it does not mine in the cambium. The zone of newly differentiating xylem provides the path of least resistance for *P. setosa* larvae who mine from young shoots to roots. Mines quickly filled with parenchyma cells. When mature these cells stored starch and increased the starch content of the xylem. To determine if mines influenced sap sugar content 300 sugar maple trees were tapped during the fall and spring and sugar values were determined with a hand held refractometer. The 10 highest and 10 lowest trees were sacrificed and sap sugar levels were correlated with mine abundance at heights of 0, 1, 4, 8, 12, and 14 m on each tree. Flecks constituted up to 1% of cross-sectional area of xylem. However, there was no correlation between fleck number or area to sap sugar levels.

Implications for parasite effectiveness of crossing *Apanteles melanoscelus* (Ratzeburg) (Hymenoptera: Braconidae) with an exotic *Apanteles* from India. R. M. Weseloh, Connecticut Agr. Exp. Sta., New Haven, CT 06504

An unidentified species of *Apanteles* from India is morphologically very similar to the established gypsy moth parasite, *Apanteles melanoscelus*, which was originally imported to North America from Europe. Behavioral tests showed that males of *A. melanoscelus* responded to the sex pheromone produced by females of the Indian form, but not vice versa. In cross mating tests males of either strain successfully mated with females of the other to produce fertile female offspring, showing that they are functionally the same species. The two strains differ substantially in cocoon morphology, that of the Indian strain being surrounded by a "halo" of coarse silk which is much less evident in *A. melanoscelus* cocoons. F_1 hybrid females result-

ing from crosses between the two strains had intermediate cocoon halo dimensions as measured by the ratio of cocoon width (including halo) to cocoon length (not including halo). Back-crosses of these females with males of either strain resulted in regression of cocoon morphology toward the appropriate pure strain, suggesting multiple gene inheritance. These results have practical implications, as *A. melanoscelus* is heavily attacked by hyperparasites in the field. The Indian strain, whose halo could serve as a barrier against hyperparasites, appears to have an inappropriate diapause response (i.e., not photoperiodically induced as it is for *A. melanoscelus*). Thus, incorporation of the halo into *A. melanoscelus* cocoons while retaining this strain's desirable diapause characteristics might result in larger field populations of the parasite.

Biotype variation and temperature effects on *Myzus persicae* (Sulz.) (Homoptera: Aphidae). M. E. Whalon and Z. Smilowitz, Pesticide Research Lab., Penn State Univ., University Pk., PA 16802

Offspring, survival and thermal requirements per developmental stage for three biotypes of the green peach aphid (GPA), *Myzus persicae* (Sulz.), were determined over a range of constant temperatures from 12.4°–29.4°C. Biotypes originated from Pennsylvania, Maine and Washington state potato producing regions. Offspring produced, survival and thermal requirements were similar for all three biotypes. Offspring production increased from 12.4° to 15.6°C and then decreased as temperature increased. Percent survival was high except at 29.4°C where only 26.7% survived. Thermal requirements, with 4°C as the lower developmental threshold, were 25.2, 27.1, 30.9, 30.7, 20.7, 74.2, 201.6 and 135.7, respectively, for instars 1–4, prereproductive adults, reproductive adults, longevity and generation time.

Since the three aphid types were of distinct karyotype, by definition they are biotypes. This definition, however, is not operational because many distinct karyotypic colonies are produced within a single potato field through parthenogenetic reproduction. A suggested operational definition for green peach aphid biotypes classifies on the basis of applied characteristics, i.e., resistance or fitness.

Updating the green peach aphid forecast system with a monitoring procedure. M. E. Whalon, B. A. Bajusz and Z. Smilowitz, The Penn. State Univ., Univ. Park, PA 16802

A dynamic, deterministic-continuous model was developed and validated for predicting green peach aphid (GPA), *Myzus persicae* (Sulz.), population development in the field. Laboratory studies of GPA development over a

range of constant temperatures provided an initial regression equation for predicting generation time. The model was derived by the regression of this independent variable on field sample data from plots maintained under Malthusian conditions, i.e., food limited only. Additional equations relating a management strategy (soil application of a systemic insecticide at planting) and predation were included in the overall model.

A capacity to predict future GPA populations was built into the model by including an algorithm to calculate day degrees from climatic data. Weather forecasts, therefore, provide input for prediction of GPA populations. The model was used to evaluate various control strategies and to predict spray dates based on weather forecasts for 80 acres of commercial potatoes and 4 acres of experimental plots.

The model was updated twice during the growing season. Water pan traps provided peak GPA immigration dates in each grower's field. A subsequent censored sample procedure and programmable calculator were utilized to estimate population parameters and parameter precision. These data were incorporated into the model via an update algorithm.

Survey and detection of the alfalfa snout beetle, *Otiorhynchus ligustici* (L.) (Coleoptera: Curculionidae). H. R. Willson, Cornell Univ., Ithaca, NY 14853

The distribution of *O. ligustici* in North America is limited to a four county area of New York. Accurate information on the dispersal of this species is essential to regulatory programs. In 1975, a grid survey of *O. ligustici* was initiated using the universal transverse mercator grid system. Alfalfa fields were sampled on a 10 km square grid to document areas of population establishment and dispersal. Initially, a biased method of digging 16 plants around the perimeter of each field sampled was followed to detect larvae of *O. ligustici*. Analysis of the detection results from the first 2 years of survey found that digging of 8 plants per field achieved 90% of the results obtained with digging 16 plants. Thus, inspector time spent per field in larval detection could be reduced. A computerized storage and retrieval system was developed to sort field data by coordinates. Since coordinates were assigned at hectare accuracy, the system can generate graphical printouts of the survey to aid decisions on future field efforts.

A comparison of the effectiveness of *Bacillus sphaericus*/SSII-1 against *Aedes stimulans* and *Ae. triseriatus* larvae (Diptera: Culicidae) at different temperatures. S. P. Wraight,[1] S. Singer[2] and H. Jamnback,[1] NYS Science Service, Biol. Field Sta., Cambridge, NY[1] and Dept. Biol. Sci., Western Illinois Univ., Macomb, IL 12816[2]

Mid to late third instar field collected *Aedes stimulans* were assayed at two temperatures against *Bacillus sphaericus* Strain SSII-1. Each assay consisted of seven different doses and one untreated control. Fifty larvae were exposed to each concentration of the bacterium in trays containing one liter of water at a depth of 1.5 cm. Larvae remained in the treated trays, and mortality was recorded until adult emergence. The inoculum used was taken from a ten day old synthetic broth culture with a total cell count of 4.24×10^9 cells/ml, total viable count of 2.01×10^8 cells/ml and spore count of 1.01×10^8 spores/ml.

Probit analysis indicated on LC_{50} of 7.23×10^5 cells/ml (95% fiducial limits at 5.88×10^5 and 8.42×10^5; slope = 5.27) at 27°C, while at 15–18°C over four times the number of cells was required to achieve 50% mortality ($LC_{50} = 2.93 \times 10^6$; 95% limits at 2.27×10^6 and 3.54×10^6; slope = 3.5). An even greater difference in the effective number of bacterial cells (5.8 fold) was observed at the LC_{95} levels (27°C – $LC_{95} = 1.48 \times 10^6$ cells/ml, 95% limits at 1.22×10^6 and 2.13×10^6; 15–18°C – $LC_{95} = 8.64 \times 10^6$ cells/ml, 95% limits at 6.80×10^6 and 1.27×10^7). In both of the above assays, a large percentage of the observed mortality occurred during the pupal stage. At dosages near the LC_{95}, most of the susceptible individuals succumbed within 6 days after treatment at 27°C and 14 days at 15–18°C. Results similar to those observed for *Ae. stimulans* have been obtained using laboratory reared *Ae. triseriatus*.

Vector potential of *Culiseta melanura* (Coquillett) (Diptera: Culicidae) in central New York State. R. H. Zimmerman and C. D. Morris, State Univ. of New York, College of Env. Sci. and Forestry, Syracuse, NY 13201

The biology of *Culiseta melanura* has been extensively studied, but it's vector potential neglected. Whether *Cs. melanura* is also the epizootic vector, as well as the amplifying vector of EEE virus in central New York State is in debate. In either case control of this mosquito decreases virus infections. By using artifical resting shelters the relative abundance and parous rates of *Cs. melanura* were monitored at 3 sites progressively farther from the center of a 5,000 acre swamp. Greatest numbers of *Cs. melanura* were first caught at the center site, but after the first week the perimeter site was more productive. The distant site had the fewest adults. Parity was progressively higher with increasing distance from the swamp. Parous rates at

all three sites increased and were approximately equal at the beginning of the year, but after the second emergence on July 31 parity was highest at the distant site. The number of parous females was 3.4 times greater at the perimeter site than at either of the other sites and, if all other factors were equal, the vector potential was greatest at the perimeter. Only 11% of a total of 405 pars collected at the distant site were caught before July 31. This would suggest an increase in importance of the distant site because EEE isolations occur after the second major emergence of *Cs. melanura* as do equine and human cases.

Erratum

The species figured in the Journal of the New York Entomological Society 86(3):212 is *Mormidea collaris* Distant. The caption for this figure was inadvertently omitted.